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POWER

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An Engineer Lawnmower

AN INDUSTRIAL establishment advertised for a first-class practical engineer to operate its steam plant.

It looked like a good opening, and an experienced power-plant engineer applied for the position.

Their idea of the sort of qualifications required and of the opportunities offered by the job was evident when they explained that the mills ran part of the time on steam and part on water, but that when the engine was shut down he would not be laid off. He could run the lawnmower.

They did not want an engineer to run the plant; they wanted a handy man to run the engine.

If this was all they wanted, they naturally did not expect to pay the salary of a skilled engineer. Some jobs do not require any more or offer any greater return or opportunities.

But sometimes a real engineer gets onto a job and develops possibilities in it that the management did not suspect

And his opportunity to carry out his ideas and even the recognition accorded to him if successful often suffer by the failure of the management to appreciate what manner of man they have in that often unimpressive personality.

We know an engineer of the practical type. He has been with a company for fifteen years. For seven years he tried to induce them to let him make changes in the power plant and in the utilization of steam.

He was finally given permission. The first year's savings were over $200,000, and the alteration paid for itself in a short time.

He got a nice letter of thanks.

Perhaps a real engineer could have found chances for improvement in the other plant that would have amounted to more than mowing the lawn

F. R. Low

POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application

Cheaper Power Through Modern Equipment

CONFRONTED with the necessity of modernizing his power plant and thus reducing power costs, the plant engineer too often considers only the possibility of doing the complete job at one time. This means the outlay of a considerable sum of money; and it is often difficult, and frequently impossible, to obtain authorization for such an expenditure.

The logical course to follow in such a situation is to make the improvements step by step. Study the plant to determine what is needed most and get that installed. Next secure authorization for the second most important modernization, and so on until the whole plant is remade.

Often the first change or two made will show such good savings that no sane management could refuse to complete the job. Anyone who does not believe that a small outlay, covering only part of the changes that should be made, can result in a major reduction in power costs, should read Mr. Benton's article in this issue. He shows how fifty thousand dollars spent saved sixty thousand dollars annually and reduced the cost of steam from fifty-two to forty cents per thousand pounds.

The Heating and Ventilating Exposition

TO THE already imposing list of annual trade expositions another has just been added—that of the heating and ventilating industry. It is gratifying to note that this branch of engineering is coming forward and proposes to bring its products into public view.

The exposition idea is an old one—almost as old as trade itself. Mention was made in a recent issue of the Leipsic Trade Fair in Germany, an institution already seven hundred years old and growing every year. Man's instinct to show his fellows what he has done is fundamental and provided he *does* something, it should be encouraged.

There is no doubt that the heating and ventilating engineer has done a great deal in the last few years, and as the public appreciation for his work grows, broader fields will be open to him. A well handled, progressive annual exhibit offers a splendid way of exciting this appreciation, and if manufacturers and engineers both do their share, the venture is bound to succeed.

Power wishes the heating and ventilating men all success in their first International Exposition in Philadelphia, 1930.

Square Bends in Welded Pipe

IN THE early days of pipe welding it was thought necessary to make 90-degree turns with well rounded elbows or even long-radius bends. When pipe lines were large, the bends were made by welding together several wedge-shaped pieces of pipe in an attempt to approximate rounded elbows. Today, however, the ends of two pieces of pipe are usually cut at 45-degrees and welded to make a square-cornered turn. This procedure results in a considerable saving, as it eliminates from one to three welds at each bend.

The designer, however, may object to the practice, believing it increases the frictional resistance, and therefore the pressure drop of the system. But is this true? Recent articles in *Power* have indicated the better performance of square bends when used in ventilating ducts. Perhaps an invesigation would show similar results for steam and water piping. Research undertaken for this purpose would not only furnish the designer with data of value in laying out welded piping systems, but would determine whether the engineer's idea of correct pipe bends has been wrong all these years.

Surface-Condenser Design

THE design of surface condensers has been greatly improved during recent years. Tubes are spaced so that steam has free access to all cooling surfaces. Steam velocities are maintained high to sweep the condensate toward the bottom of the condenser as quickly as formed. The condensate is maintained practically at the temperature of the vacuum. Entrained air is withdrawn uniformly from the condenser surface and cooled before entering the air-removal apparatus. With this progress in mind one may question whether any further large improvements can be made in the design of this equipment.

The surface condenser is rather a minor item in the total cost of a power plant, so that any reductions in its first cost will not greatly lower total station cost. However, it appears that there may be possible modifications of surface-condenser design that may lower its first cost.

Several large condensers have been in operation for some time with tubes rolled into the tube sheets at both ends. This construction saves the costs of ferrules, and of counterboring and tapping holes in the tube sheet for them. The cost of packing material is also saved. It is said that these condensers have given practically no trouble from leakage. This may prove one step toward lower first cost.

In Europe condensers to be used with fresh circulating water are frequently built with wrought iron in place of brass or Muntz metal for tube sheets, to provide cheaper construction. Wrought-iron tubes have also been considered for the same purpose. A recent process of making wrought iron may make more of this material available probably at a lower cost than at present, so that this material should be considered for fresh-water condensers.

The art of welding has been developed so well that the construction of welded condenser shells and water boxes of steel or wrought iron in place of cast iron should receive serious consideration. These would be lighter in weight, easier to handle and freight charges would be less.

All these modifications in surface-condenser design are suggested as means for lowering first cost. They should receive careful consideration, since present trends in plant design are decidedly toward lower station costs.

Before, Not After a Cataclysm

A CATASTROPHE is frequently required to move legislative bodies to action. The year 1927 was peculiar in this respect: The Mississippi River flood resulted in a comprehensive program by the national government for controlling the "Father of Waters." In Vermont, scarcely more than a year after the flood of 1927, an advisory committee of engineers has reported, to Governor Weeks, an extensive plan of reservoir construction for river regulation and power development.

According to this report losses due to the flood represented seventy-five per cent of the estimated cost for reservoirs eliminating the hazard. By combining power projects with storage reservoirs it is possible to make these undertakings financially self-supporting, even with power-development costs approximating those for reservoirs.

Theoretically, river-control and power-development operations do not synchronize. Flood-control reservoirs should be empty except when the flow exceeds the river's safe capacity. In reservoirs for power development all water not passing through the plant is stored. As operated, these reservoirs are drawn down for power generation in low-water periods to provide storage for seasonal floods. It is possible, however, for an unexpected flood to occur when the reservoirs are full.

In either case, storage reservoirs provide an effective means of flood control, particularly on small rivers, which was the experience on the Deerfield in the Vermont flood of 1927. This river was in the area of heaviest rainfall, but the storage reservoirs prevented serious damage along its course. Probably another flood of equal volume could have been handled on this river without disastrous results. Even when heavy rainfalls occur with full reservoirs, the storage capacity above the spillway level is sufficient to smooth out the flow and prevent unusual floods.

Vermont has experienced a disastrous flood on uncontrolled rivers and has seen the hazard overcome on a stream with storage reservoirs for power development. This should be sufficient to stimulate prompt action on a concrete program to prevent a recurrence of the catastrophe of 1927. Other states may well study the lessons in flood control and power development being learned by the Green Mountain State, as the time to prepare for flood control is before, not after, a cataclysm.

Let There Be No More Delays

NOWHERE in this country can water power compete with steam more easily than at Niagara Falls. On the American side the total output of the plants is sold for less than three mils per kilowatt-hour, a figure about equal to the cost of coal delivered under the boilers in the average steam plant. Furthermore, Niagara power is dependable. In the face of these facts, steam plants on the Niagara system grow rapidly, as witnessed by the one hundred-thousand-horsepower unit that recently went into service.

Niagara Falls is one of the greatest, if not the greatest, single source of water power in the world. There are falls of greater magnitude, but the constant flow and volume of the Niagara River make it outstanding as a potential kilowatt-hour producer. If the total flow were utilized in an over-all development, about forty billion kilowatt-hours could be generated. This is equivalent to fifty per cent of the power generated by central stations in the United States last year. At the average coal consumption rate per kilowatt-hour in central stations about thirty-five million tons would have to be burned to produce this power.

True, not all of the power can be developed. Nor do those who have the interests of Niagara Falls at heart wish to see such a thing happen even if natural conditions did not preclude it. But the fact that one of the largest steam plants in the United States has been built practically at the Falls, while over eighty per cent of the latter's potential energy runs to waste, is a serious indictment.

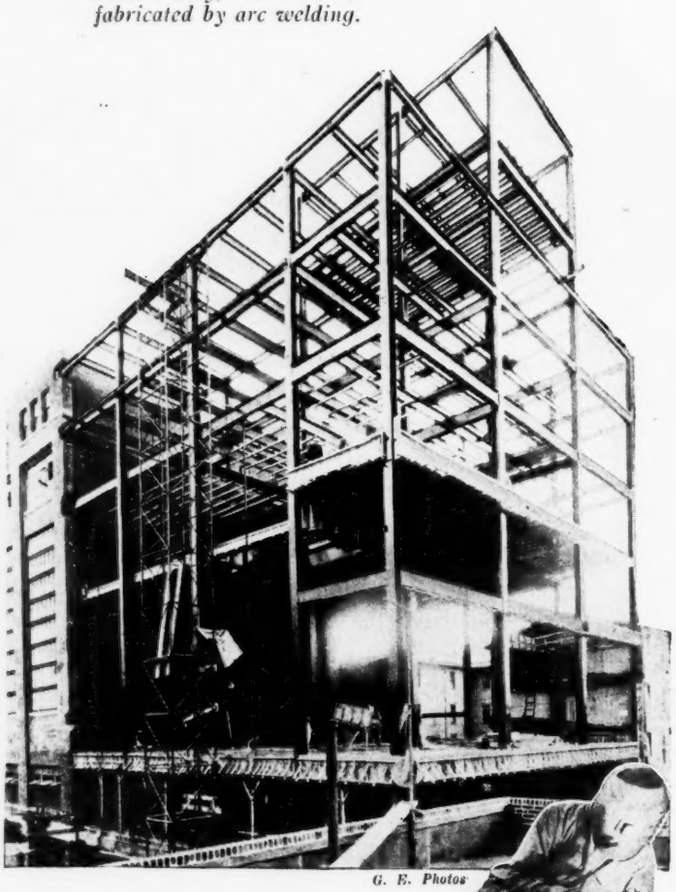
Representatives of this country and Canada recently signed an agreement for an increased water diversion for power generation, after suitable remedial works are constructed to preserve the Falls' scenic beauty. Congress must pass upon this project before it becomes operative. It should do this without delay, as the project has been recommended after two years of careful study by an international board of engineers, appointed by the United States and Canada. Without this approval no further use of Niagara's water can be made for power purposes and steam plants must increase in size to supply the power that could be more cheaply obtained from water.

WELDING MOVES AHEAD

Electric Arc and Oxyacetylene Welding Processes Find

Countless Applications in the Power Field

STEELWORK *of new power plant of Chalfonte-Haddon Hall Hotels, Atlantic City, N. J., is fabricated by arc welding.*

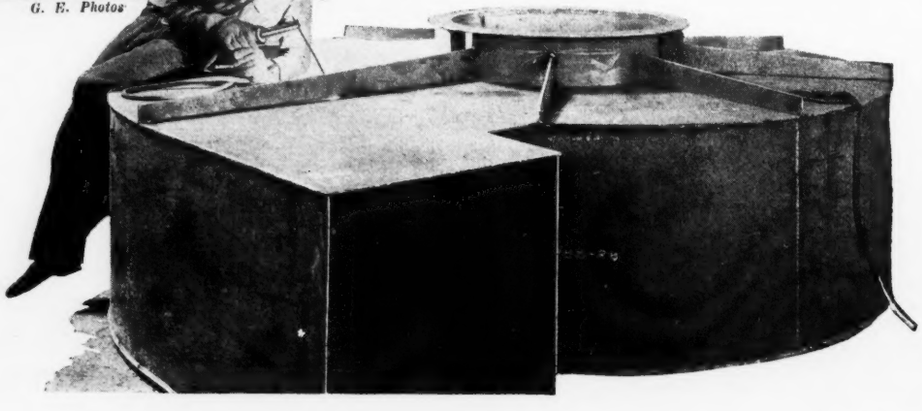


G. E. Photos

FEW realize the extent to which fusion welding by the oxyacteylene and electric-arc processes is now applied to the fabrication, installation and repair of power equipment. While the advantages and disadvantages of welding are being debated in the meetings of engineering societies and elsewhere, many manufacturers and an increasing number of contractors and power engineers are adopting welding as an essential tool of their daily work.

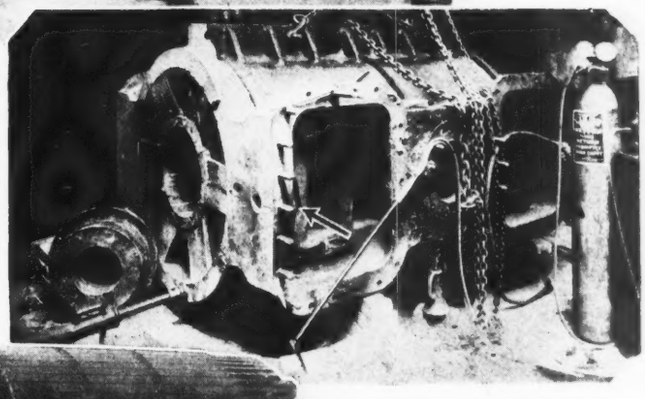
The photographs on this and succeeding pages are reproductions of some of the slides shown by P. W. Swain, managing editor of *Power*, in connection with a paper on the "Present and Future of Welding in Power Plants," presented before the Metropolitan sections of the A.S.M.E. and the American Welding Society in New York City on the eighth of January. These pictures, picked at random from a much larger group, give some idea of the breadth of application, although the selection does not sufficiently emphasize the use of welding for the fabrication of piping systems. This is now, and may continue to be, the outstanding application, because of the adaptability of welding for the purpose and the immense amount of piping used in the generation and transmission of the various power services, including steam, water, refrigeration, compressed air, heating and ventilation.

DUST COLLECTOR *fabricated by arc welding at Detroit plant of American Blower Company.*



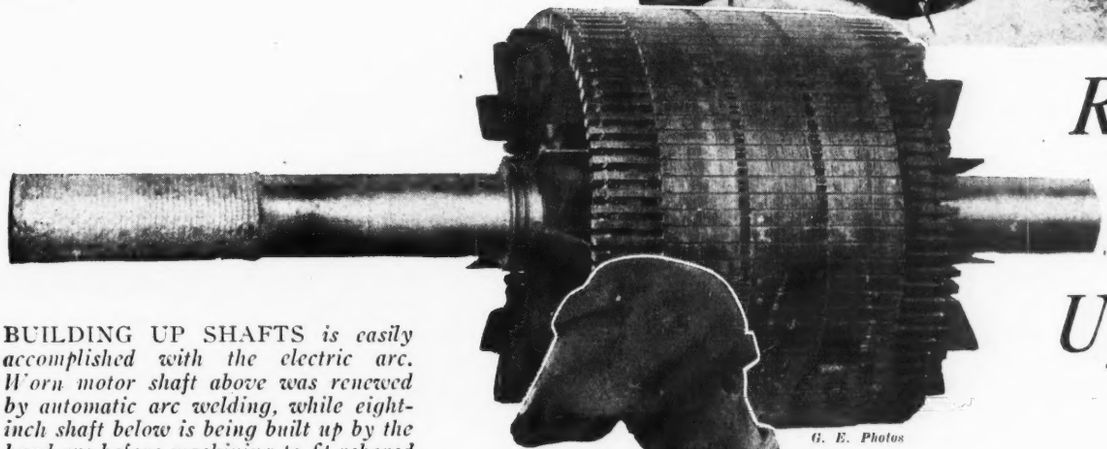
IN THE POWER PLANT

Linde Photos



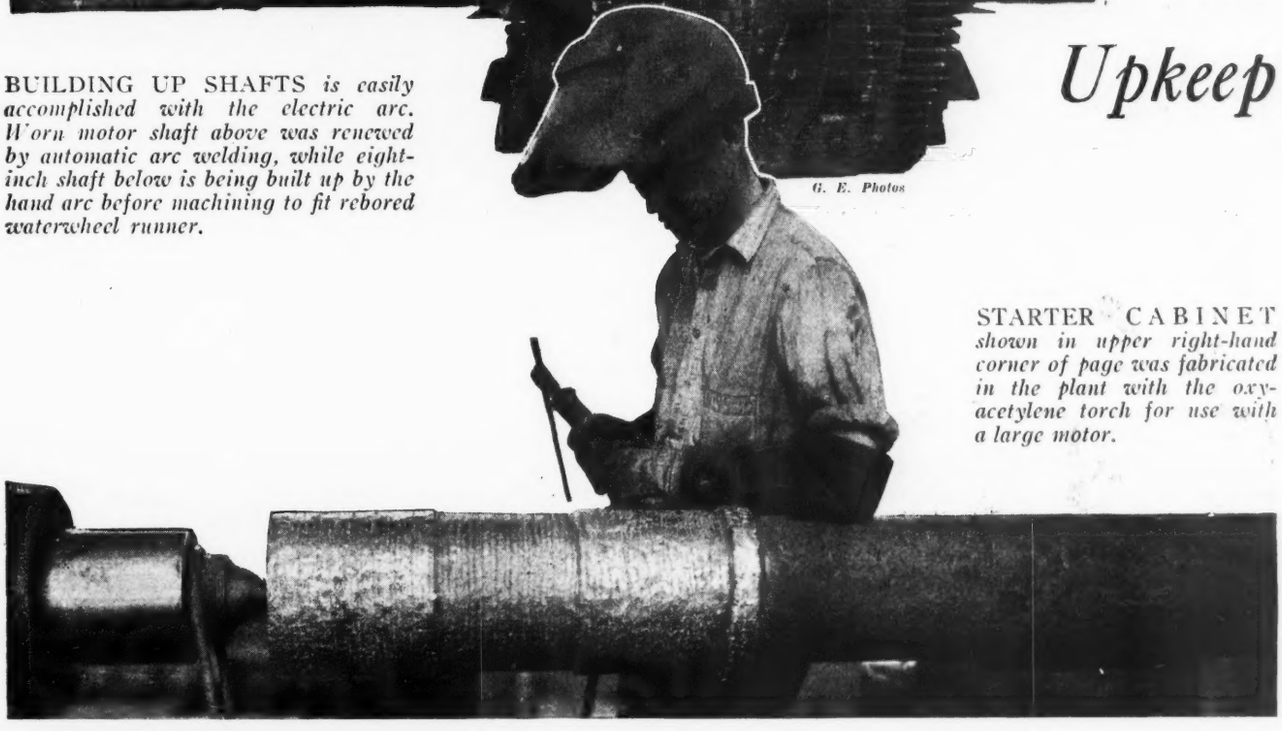
REPAIR AND DEMOLITION *offer many opportunities to use the oxy-acetylene torch. Photo above shows use of cutting torch to remove obsolete engine. At right is broken cylinder head of blowing engine repaired by welding.*

Repair and Upkeep



G. E. Photos

BUILDING UP SHAFTS *is easily accomplished with the electric arc. Worn motor shaft above was renewed by automatic arc welding, while eight-inch shaft below is being built up by the hand arc before machining to fit rebored waterwheel runner.*

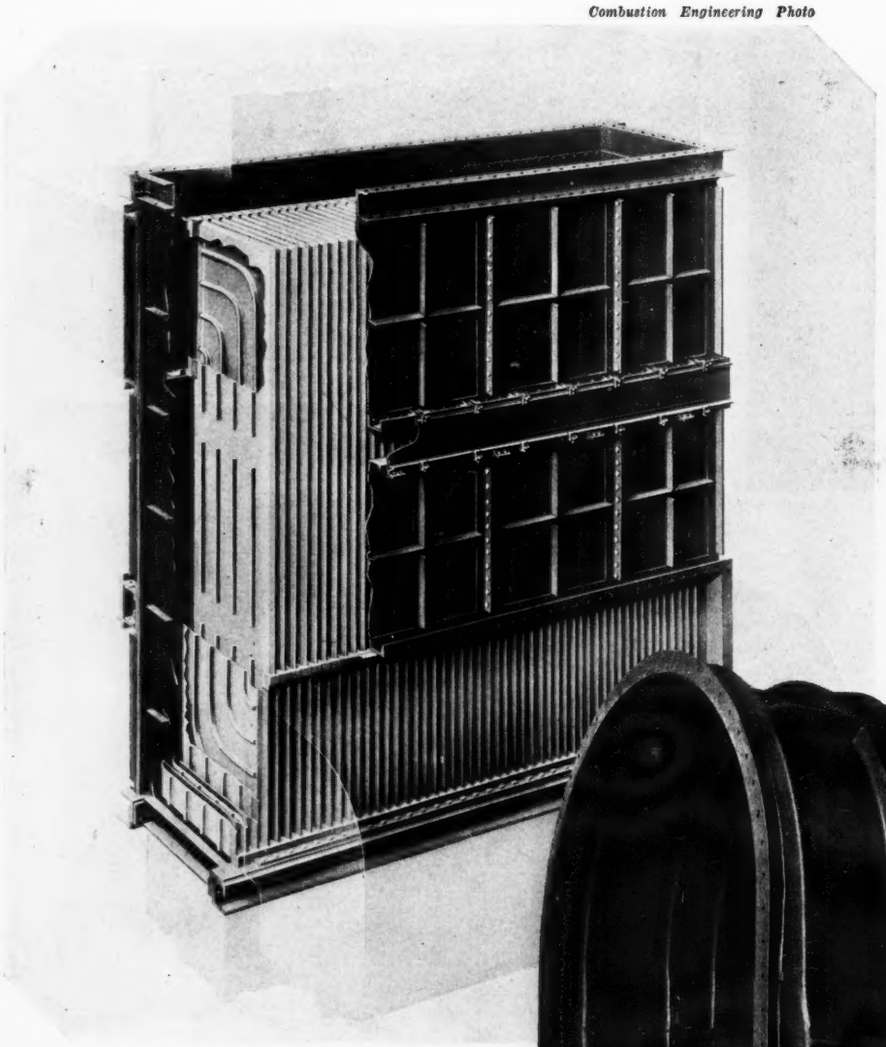


STARTER CABINET *shown in upper right-hand corner of page was fabricated in the plant with the oxy-acetylene torch for use with a large motor.*

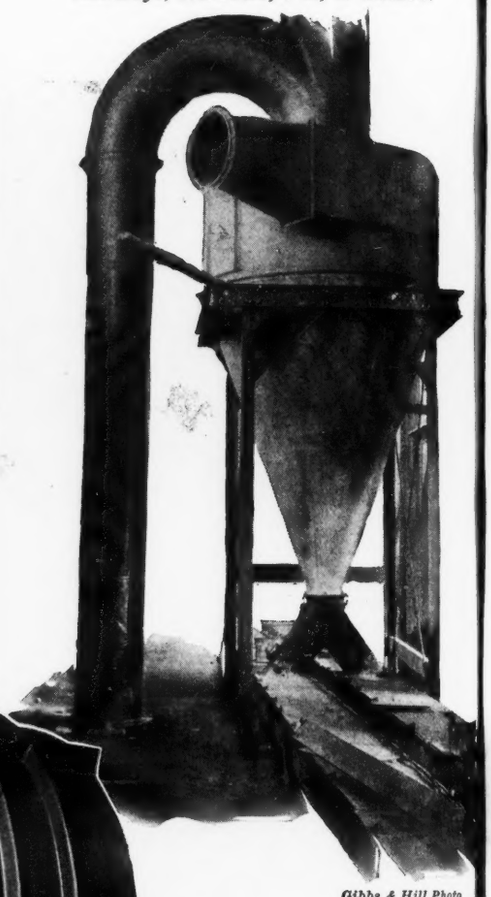
In the Boiler House

AIR HEATER *of the plate type, fabricated by electric welding.*

Combustion Engineering Photo



DUST COLLECTOR *for pulverized coal in plant of Virginia Railways, Narrows, Va., is welded.*



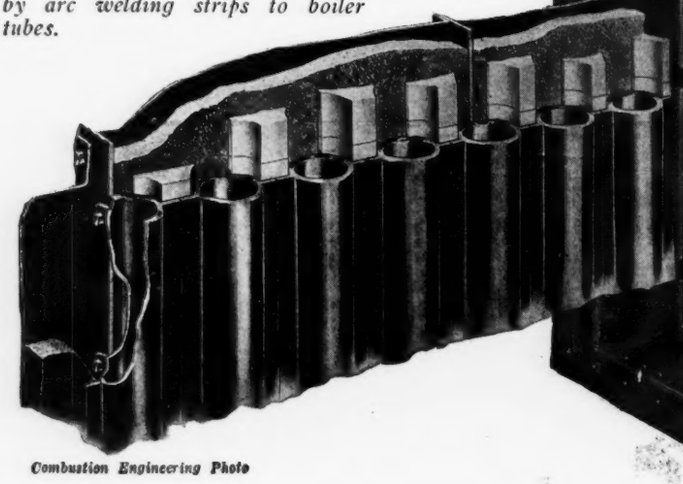
Gibbs & Hill Photo

BOILER HEADER (*below*) *in which the tube connection is crimped for strength and seal welded for tightness, as permitted by A.S.M.E. Boiler Code.*

Connery Photo

BREECHING (*right*), *fabricated by arc welding, combines tightness with provision for expansion.*

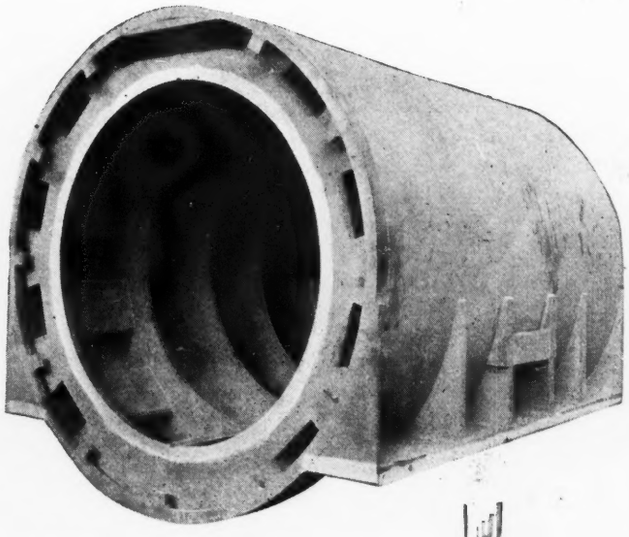
FIN TUBES (*below*) *for boiler furnace water walls are fabricated by arc welding strips to boiler tubes.*



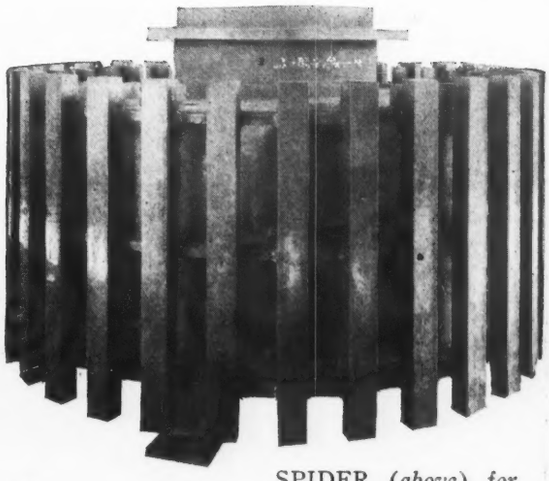
Combustion Engineering Photo

Combustion Eng. Photo

Electrical Applications

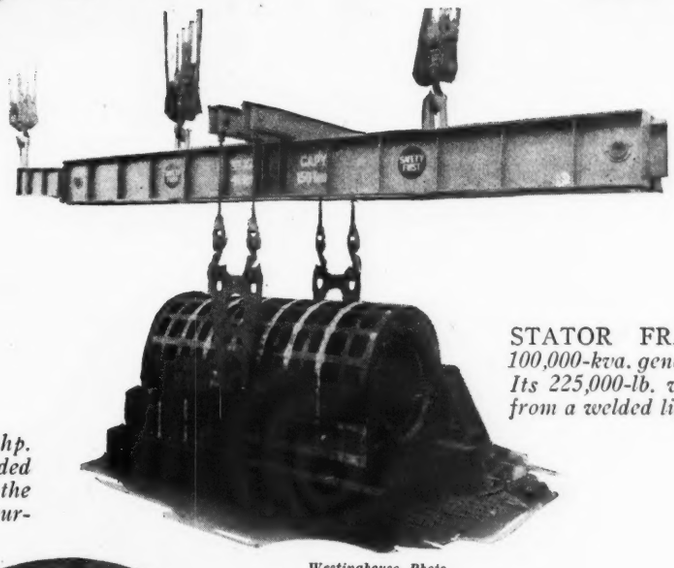


G. E. Photos



SPIDER (*above*) *for armature of 3500-hp. reversing-mill motor is fabricated entirely by arc welding.*

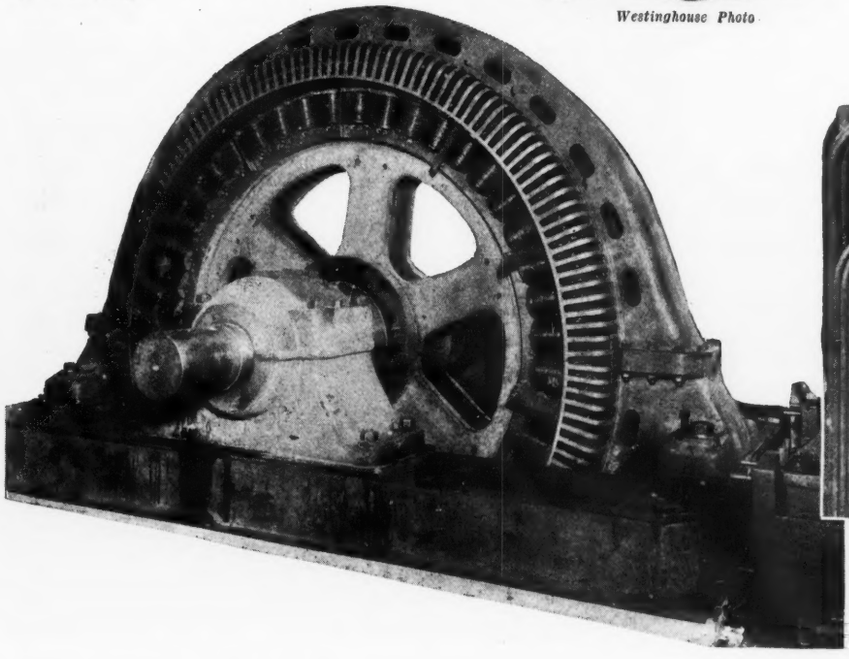
STATOR FRAME (*above*) *for large generator is fabricated entirely by electric welding.*



STATOR FRAME (*left*) *for 100,000-kva. generator is arc welded. Its 225,000-lb. weight is suspended from a welded lifting beam.*

BASE (*below*) *for 1,500-hp. synchronous motor is arc welded from structural shapes by the Electric Machinery Manufacturing Company.*

Westinghouse Photo

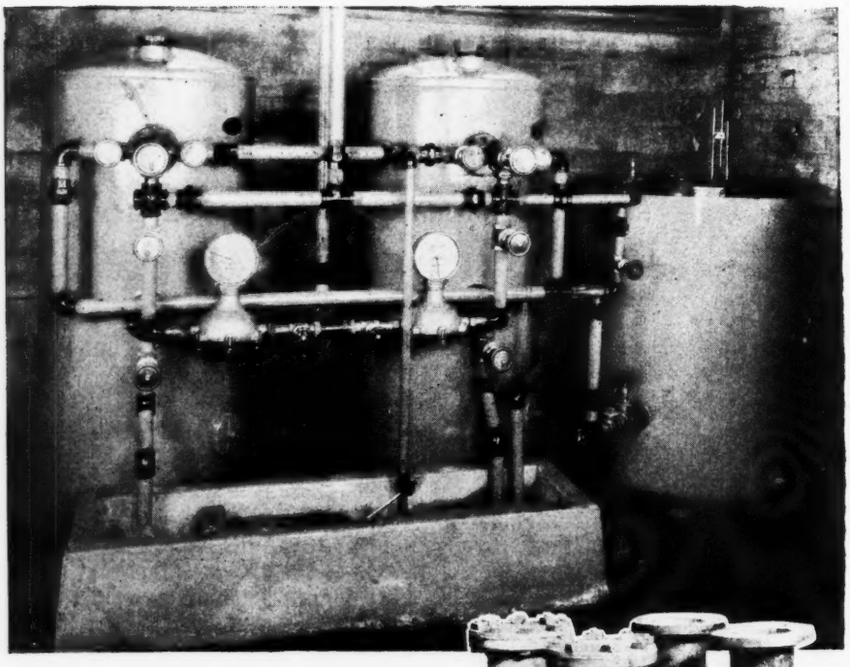


Lincoln Electric Photo

G. E. Photo

TRANSFORMER *tank being arc welded on the bottom.*

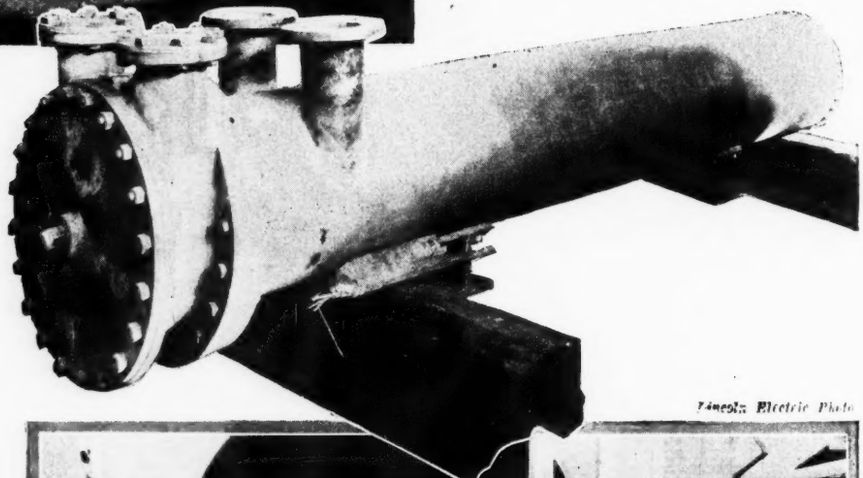
Piping and Pressure Vessels



Permutit Photo

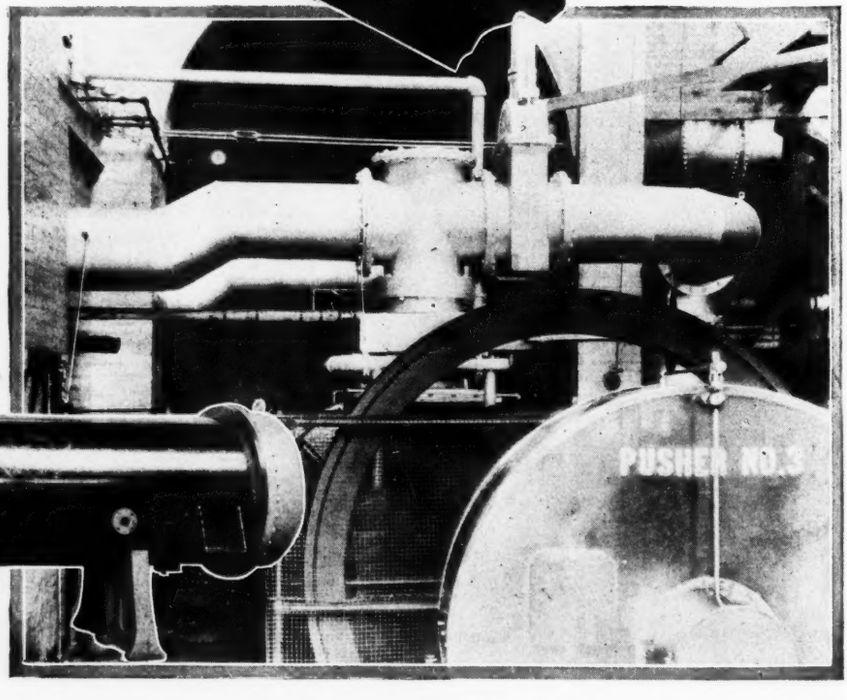
ZEOLITE SOFTENER (*left*) *in which the tanks are welded by the electric arc.*

HEAT EXCHANGER (*below*) *has nozzles and flanges attached by oxy-acetylene welding.*

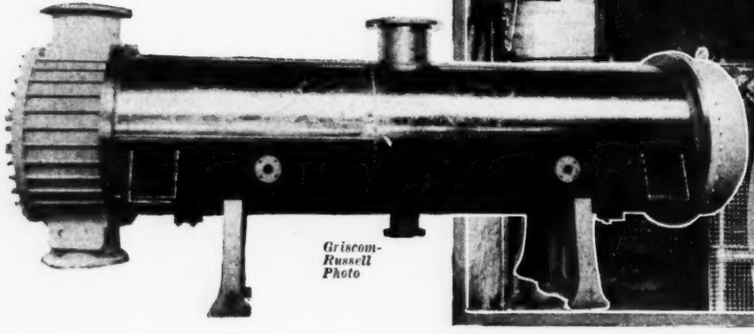


PIPING *is extensively welded by the oyxacetylene and electric-arc processes. Photo in lower right-hand corner shows arc-welded piping in the plant of the Minneapolis Gas Light Company.*

Lincoln Electric Photo



EXTRACTION HEATER (*below*) *for central-station use. Shell, nozzles, brackets and flanges are welded.*



Griscom-Russell Photo

SIMPLE CHANGES

That Reduce Wastes

Result in Large Savings

By H. W. BENTON
Plant Engineer, Pratt & Whitney Company, Hartford, Conn.

Modernization Program Costing $50,000 Nets $60,000 Annually, Lowering Cost of Steam by Twelve Cents per Thousand

WHEN industrial power plants are modernized, large savings can be made as the result of simple changes. This fact was brought out by my experiences at the Willys-Morrow Company, Elmira, N. Y., where I was formerly employed as maintenance engineer. This plant realized over $60,000 annually from simple improvements.

The boiler room, before changes were made, had six 3,000-sq.ft., Type S-15, Stirling boilers, equipped with old-style Jones underfeed stokers, and two 1,500-sq.ft., hand-fired, McNaul water-tube boilers. A forced-draft fan, driven either by a steam engine or from an electric motor, supplied the draft. The boilers operated at an average pressure of 135 lb. An open feed-water heater of appropriate size was also installed.

EQUIPMENT IN THE ENGINE ROOM

In the engine room the following equipment was placed: One 800-cu.ft., Ingersoll-Rand two-stage air compressor; one 1,100-cu.ft., Ingersoll-Rand two-stage air compressor; one 2,200-cu.ft., Nordberg two-stage air compressor; two boiler-feed pumps; two general-service water pumps; two 1,000-g.p.m. fire pumps.

A steam-jet ash conveyor was installed along the fronts of the boilers, so placed that ashes could be delivered to it directly from the ashpit.

Two high-pressure steam mains, one 6-in. and one 8-in., took steam 540 ft. from the boiler house to the drop-forge building for the operation of steam hammers. It had been thought that, when all the hammers were operating, the 8-in. main would be needed; while the other would serve when only part of the hammers were used. These two mains were connected to a receiver, from which branches led to the machines.

The exhaust steam from this equipment was piped to a receiver vented to the atmosphere, all the exhaust being wasted. Steam supplied to the drop-forge plant, averaged from records covering fourteen months, was 8,960,000 lb. per month.

Heating and process steam was carried to manufacturing departments through a 6-in. main, 1,065 ft. long. The heating lines branching from this main were fed through regulating valves, maintaining a constant pressure on the heating system.

Total heat loss due to heating, atmospheric exhaust, condensation in mains and vacuum return lines, amounted to 96,433,586 B.t.u. per hour. In addition, the heat converted to energy or otherwise used in the power and process equipment made a load on the boilers considerably in excess of the figure given.

From actual flow-meter records the steam produced from the boilers during a typical year was as shown in Table I.

TABLE I—WATER EVAPORATED, BY MONTHS

Month	Pounds Evaporated
January	33,772,000
February	27,436,000
March	30,708,000
April	23,918,000
May	18,725,000
June	10,991,000
July	9,873,000
August	9,930,000
September	11,036,000
October	16,536,660
November	20,119,000
December	26,857,450
Total	239,912,110

During the period when this evaporation was recorded, other costs were incurred as shown in Table II.

TABLE II—YEARLY POWER HOUSE COSTS

Coal used, 18,330 tons	$73,320.00
Boiler-house payroll	21,403.00
Engine-room payroll	5,694.00
Coal-handling costs	4,266.00
Miscellaneous supplies	918.00
Repairs	6,364.00
Depreciation	13,210.30
Taxes	840.45
Insurance	408.14
Light	240.00
Total yearly costs	$126,664.00

These cost figures, taken with the total steam generated, give a cost per 1,000 lb. of steam equal to 52.3 cents.

CHANGES THAT REDUCED COSTS

It had been customary to operate the 2,200-cu.ft. air compressor by synchronous motor drive for four months each year. The expenditure for purchased current for this purpose was $5,062. During the eight months of the heating system this compressor was operated by a cross-compound Corliss engine connected tandem on the

piston rods of the air cylinders. The exhaust steam from this engine was in part used for heating and in part exhausted to the atmosphere. When the air unloader cut out the compressor, the synchronous unit on the shaft acted as a generator. The average daily production of electricity from this source was 965 kilowatt-hours.

A Burnham steam-driven vacuum pump and jet condenser were installed in connection with this Corliss engine, so as to provide condensing operation when the exhaust was not needed for heating. During the heating season the condenser is shut down and the engine exhaust, as formerly, goes into the heating mains. As a result of this change the byproduct power from the compressor operation was increased to an average of 3,980 kw.-hr. daily, a saving of $79.60 per day.

The old-type Jones stokers were replaced by new, side-dumping Jones stokers. This change was made at moderate outlay and gave a guaranteed efficiency of 74 per cent for boiler and furnace combined, which is good for this type of plant.

The railway siding is in line with the boilers and runs alongside the boiler house at a level eight feet above the floor. There was storage capacity for several carloads under this track.

COAL-HANDLING costs are too often overlooked when the industrial plant seeks to obtain its power cheaper through modernizing its equipment. While it is true that larger savings can often be made through increasing the efficiency of boilers or prime movers, or through cutting down heat wastes, five cents saved in handling each ton of coal mounts up to a considerable sum in a year. Never let coal handling waste the profits that are made elsewhere in the plant.

Formerly, all coal was delivered to the firing floor in wheelbarrows. To correct this condition, a 200-ton bunker was installed in the boiler room, with coal spouts to the stoker-hoppers, provided with shutoff gates operated from the floor. A fourteen-foot square track hopper was placed under the track, with a reciprocating feeder underneath. This feeds to a crusher that discharges into a bucket elevator, in its turn discharging into the 200-ton bunker.

A new coal storage, 100x150 ft., provides space for 5,000 tons. A three-ton, monorail crane operates over this storage pile and reclaims coal as necessary. Coal for storage is emptied from the cars into a new concrete coal pocket of 150-ton capacity, 80 ft. long, and placed under the track adjacent to the new track hopper. The cost of labor for storing and reclaiming coal with this new equipment is $0.04 per ton and requires the labor of two men while the operation is being carried out—one on the cars and one on the hoist.

Only one man is required to take coal from storage to bunker. The coal-handling equipment is operated by the regular boiler-room men, and the monorail operator brings coal from storage to track hopper to feed this equipment when coal is not being taken directly from the cars. In this latter case the labor cost is 2¼c. per ton.

The steam ash conveyor, which had been previously installed but never used, was put in working order and has proved satisfactory.

The 8-in. high-pressure steam line to the drop-forge plant was converted to a low-pressure line, and all the high-pressure steam for this department taken through the 6-in. line. Necessary valves and a 16-in. oil separator were put in the 8-in. line, and it was used to return steam from the hammers to the 16-in. low-pressure heating main. During the summer the hammer exhaust still goes to the atmosphere.

These changes and some minor adjustments were made for a total cost of less than $50,000. Also, all steam traps, valves, joints and other parts of the system were put in first-class condition.

As a result of this modernization laboring conditions have been made pleasanter and more satisfactory. Boilers are now operated regularly at 165 per cent of rating.

Flow meters on all lines permit accurate records to be kept.

The monthly figures for operation since the changes are given in Table III.

TABLE III—MONTHLY COST FIGURES OF MODERNIZED PLANT

Total water evaporated, lb.	32,602,500
Coal	$9,744.30
Supplies—Miscellaneous	102.09
Labor, boiler room and engine room	1,458.05
Repairs	530.08
Depreciation	1,075.00
Taxes	64.45
Insurance	30.14
Light	20.13
Total	$13,024.24

These figures show a cost for steam, all charges included, of $0.40 per 1,000 lb. generated. Compared to the cost before the changes, this is a saving of 12.3c. per thousand. On the basis of the yearly performance of 239,912,110 lb. of steam generated, this would give a saving of $29,518.64. But the company's business has grown and more steam is actually produced today, with only four boilers in service than previously with five, and the McNaul boilers have been taken out of service.

Complete figures of savings made, including steam costs, electricity generated and use of drop-hammer exhaust, are $61,838.64 annually, these taken from the power-plant records.

Better Use of Byproduct Heat

Condensers are often considered a necessary part of the power plant that generates electric current. But often their use entails a definite waste of heat that might be avoided. For an illuminating discussion of this point, read the article entitled "Condensers in Industrial Plants Mean Wasted Heat," by E. H. Barry, in Power for Feb. 5, 1929.

The Archaouloff "Solid Injection" System for Diesel Engines

By A. J. Diakoff

Assistant Professor,
University of North Dakota

INJECTION and atomization of liquid fuel in Diesel engines by means of highly compressed air is being more and more replaced by solid injection; that is, the injection of liquid fuel under direct pump pressure of a few thousand pounds per square inch. The main advantage is the elimination of the high-pressure compressor.

Almost all of these designs have a cam-driven pump to produce the high pressure required for the solid injection.

Pumps Are Better Adapted for Small Engines

These pumps work quite satisfactorily on small engines, but when they are applied to large ones, considerable difficulty is encountered, for the sharp strokes of the cams operating under the heavy loads throw the entire pump mechanism into disorder. Besides this, when the speed of the engine falls below normal, which often happens in marine engines, the energy of the cam-driven pumps becomes weak and the intensity of injection drops, causing poor combustion in the cylinder and a smoky exhaust.

The Archaouloff system of solid injection has no cam-driven pump. It is mechanically independent of the crankshaft of the engine and does not require any reversing devices when the direction of rotation of the crankshaft is changed.

The apparatus is operated by means of a pneumatic amplifying displacer which is actuated by the pressure in the cylinder of the engine; the knocks are eliminated and the operation of the system is absolutely noiseless.

The arrangement applied to the cylinder of a two-stroke-cycle engine of 500 hp. is shown in the illustration.

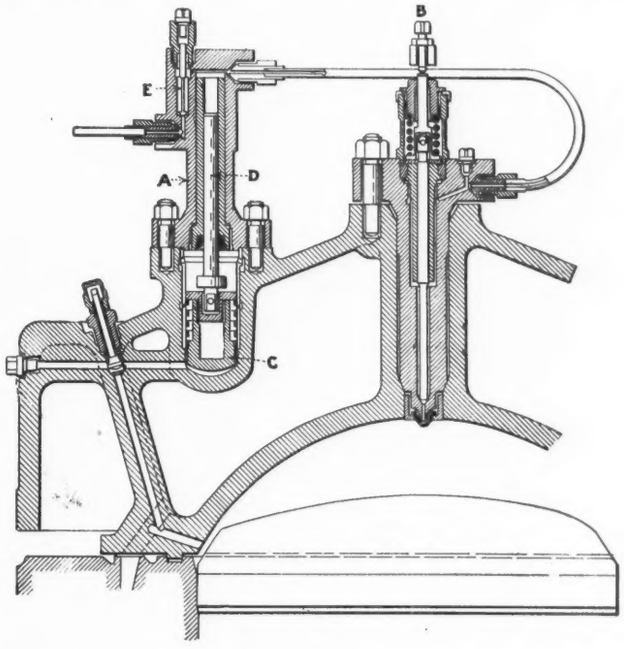
The mechanism consists of two main parts, a pneumatic amplifying displacer *A* and an injector *B* with a spring-loaded differential needle. The displacer *A* is made up of a cylinder in which moves a piston *C* directly connected to a plunger *D* which is snugly fitted into a bushing. The lower part of the cylinder is in constant connection with the combustion chamber of the engine by means of drilled passages.

How the Pump Works

The fuel pump, not shown on the drawing, sends a definite quantity of fuel through the valve *E* into the space above the plunger *D* and forces the plunger, together with piston *C*, down a sufficient distance to allow one complete charge of fuel to enter above the plunger. This occurs at the time when the pressure in the engine cylinder is approximately equal to atmospheric, reducing the work of the engine's low-pressure fuel pump to a minimum. When the pressure in the cylinder of the engine increases during the compression stroke, the pressure in the cylinder of pneumatic amplifying displacer simultaneously increases, and piston *C*, moving upward, increases the pressure on the fuel in the space above the plunger *D*. This increasing pressure on the fuel is transmitted through a pipe to the interior space of the injector *B*. Here it acts upward on the differential area of the needle and lifts the needle off its conical seat.

The ratio of the cross-sectional areas of the piston *C* and the plunger *D*, the differential area of the needle and the compression of the spring, permit the exact predetermination of the pressure of compression in the cylinder of the engine at which the differential needle will be lifted from its seat, permitting the injection of fuel to begin. These factors also permit the adjustment of the fuel pressure at the moment of injection.

With a compression pressure of 385 lb. per sq.in. the injector is regulated so that preinjection occurs when the cylinder pressure reaches 355 lb. With a ratio of cross-sectional areas of piston *C* and plunger *D* of about 12 to 1, the pressure of injection at the instant the needle opens is about 4,200 lb. per sq.in., but it immediately increases to 6,600 lb. when combustion begins. This instantaneous and very large increase of pressure on the fuel as it is injected is one characteristic feature of the system and this advantage occurs just as well at low engine speeds as it does at high speeds.



The Archaouloff system applied to a two-stroke-cycle engine

The moment of preinjection can be changed even while the engine is in operation, by altering the compression of spring of the differential needle by means of the adjusting nut. The lift of the differential needle is not more than 0.030 in., so that the spring works almost as if it were statically loaded, guaranteeing positive action.

The apparatus is furnished with a simple device, not shown in the section, for automatically blowing out all drilled passages with fresh cold air after every working stroke. This keeps the pneumatic cylinder and passages entirely free from accumulations.

The Archaouloff System can be installed without any difficulty on oil engines that are already in operation, and without the slightest change in engine construction.

A considerable number of European Diesel manufacturers have installed, or are installing Archaouloff's solid-injection system on engines of various sizes.

Large Hydro-Electric Generator Repaired by Unique Method

By E. J. Kingsbury
Mechanical Engineer,
Los Angeles Bureau of Power and Light

SAN FRANCISQUITO Power Plant No. 2 of the Bureau of Power and Light is approximately forty miles from Los Angeles, California. This hydro-electric plant was completely wrecked by the flood water from the St. Francis Dam, which was used as a storage for domestic water supply only. This plant consists of two 20,500-hp. waterwheels driving 17,500-kw. vertical generators and operating under a static head of 540 feet.

At one period of the flood these units were covered with water, sand, gravel and other débris to a depth of 125 ft. Unit No. 2 was in operation at the time, and although the building was completely destroyed, this unit continued to run until water could be turned off at the head of the penstocks, about three hours later.

After all débris had been removed and the inspection of the units completed, it was found that unit No. 2 was in bad condition. Both mechanical and electrical sections of this unit required extensive repairs, but the primary purpose of this article is to describe the method and equipment used to repair the sections of the generator-rotor shaft, which was badly cut and sprung.

The section of the shaft extending through the rotor is approximately 21 ft. long terminating in a forged coupling on the lower, or turbine, end. This shaft is twenty inches in diameter where it passes through the rotor. The rotor, 8 ft. 5 in. in diameter and weighing 72 tons, is built up of laminated sections and shrunk on the shaft as shown in the several photographs.

After an investigation it was found impractical to remove the shaft from the rotor, and as there were no machine tools of sufficient capacity available in Los Angeles to handle the assembly, this, together with the great weight and mass, which would have to be transported 40 miles, made it imperative that work be done on the site.

It was necessary to straighten the shaft to reduce the cut required to recondition the rotor guide bearings and also to avoid the necessity of reaming the bolt holes in the coupling. In addition the liability of excessive deflection of the shaft if suspended at the outer ends made it necessary to support and rotate the assembly by means of large adjustable rings placed on the outside of the laminated rotor core, as shown in several of the figures.

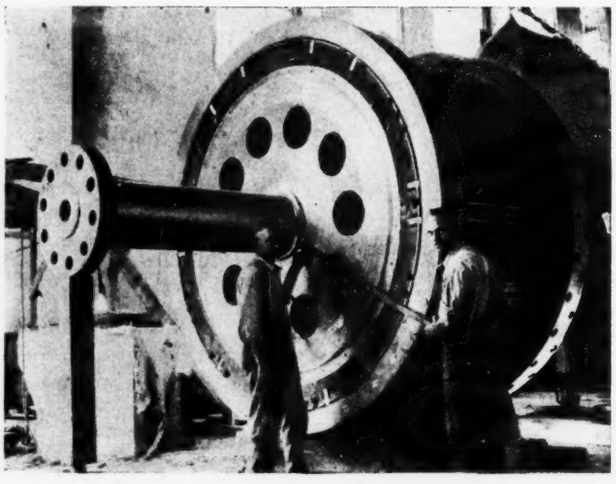


Fig. 1—Two rings were centered on the rotor to act as a lathe chuck

During the recent failure of the St. Francis Dam on the Los Angeles, Calif., water system, hydro-electric power house No. 2 of that city was completely wrecked, which necessitated difficult and quick repairs to certain parts of the equipment. This article tells how the shaft of one generator rotor, weighing 72 tons, was straightened and conditioned in the plant, without taking the rotor off the shaft.

After taking the rotor from the unit and removing the polepieces, it was laid in a horizontal position on blocking, leaving both ends of the shaft and rotor free, as shown in Fig. 1. Two special nickel-chromium cast-iron rings having a section of 8x10 in. were turned true and one placed over each end of the rotor, the function being that of chucks to carry the entire rotor assembly shown in Fig. 1.

The adjustment of the rings was made by sixty-six 1½-in. hardened-steel adjustment screws, offset and countersunk, spaced equally around the periphery, leaving a true bearing surface, shown in Figs. 1 and 3.

Adjacent to either side of the rotor is a known true surface of the shaft. From these surfaces the outside circumferences of the rings were adjusted concentric with the shaft. Between the rings and rotor ⅜-in. steel bearing plates were placed to prevent the adjustment screws from coming in direct contact with the soft-iron laminations of the rotor. Where slots come under the adjusting screws steel blocks were inserted to take the thrust as in Fig. 3.

A concrete foundation was used under the turning mechanism and extended in two piers to support the turning tools, Fig. 2, making, as it were, a mammoth machine-tool frame. Two eight-inch steel shafts, placed four feet apart and parallel, were supported by six bearings shown in Fig. 2. The function of the shafts was to form a roller-bearing support for the rotor assembly, one shaft acting as a driver and the other as an idler. The former was driven by a motor through a worm gear and chain drive, Fig. 3.

The chuck rings on the rotor rested on true ground bearing surfaces and were held in place by steel collars, shown in Figs. 2 and 3. The six bearings were so designed that an oil pressure of 1,000 lb. per sq.in. could be carried while starting and a pressure of 250 lb. used while running, giving a constant circulation of oil, thus

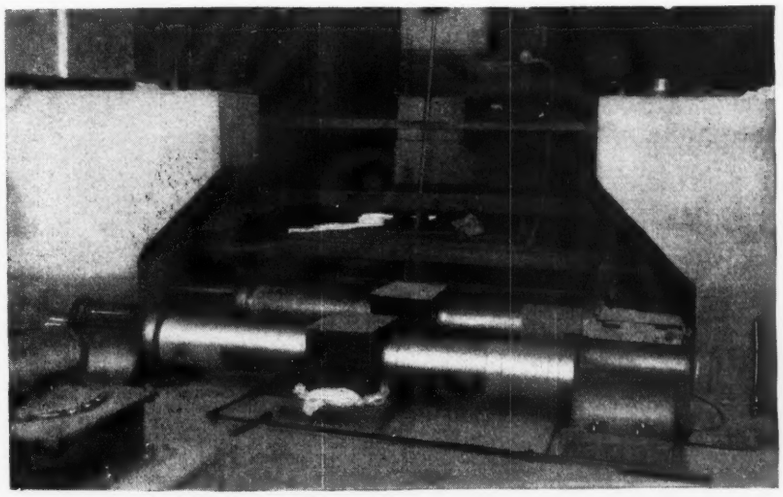
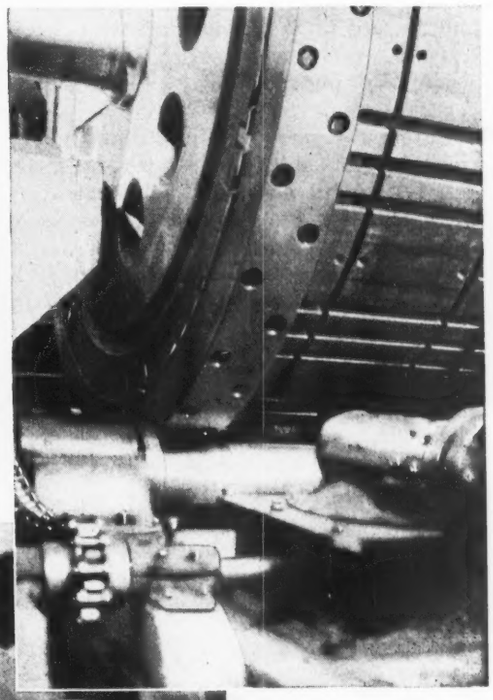


Fig. 2 (Above)—Rollers on which rotor was revolved



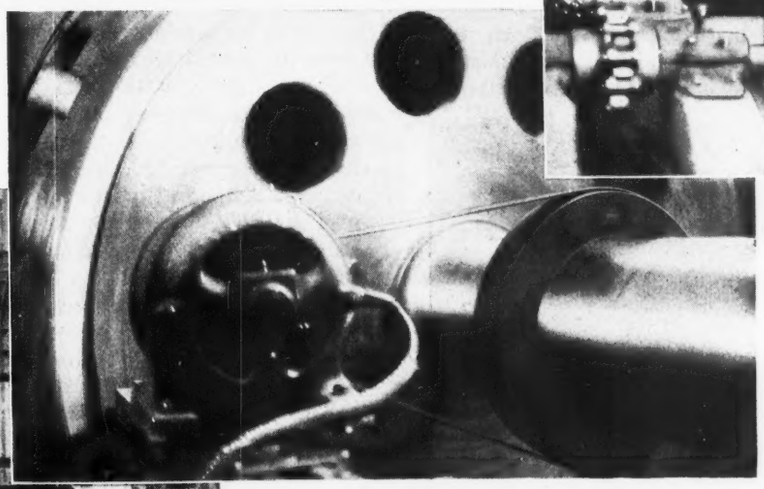
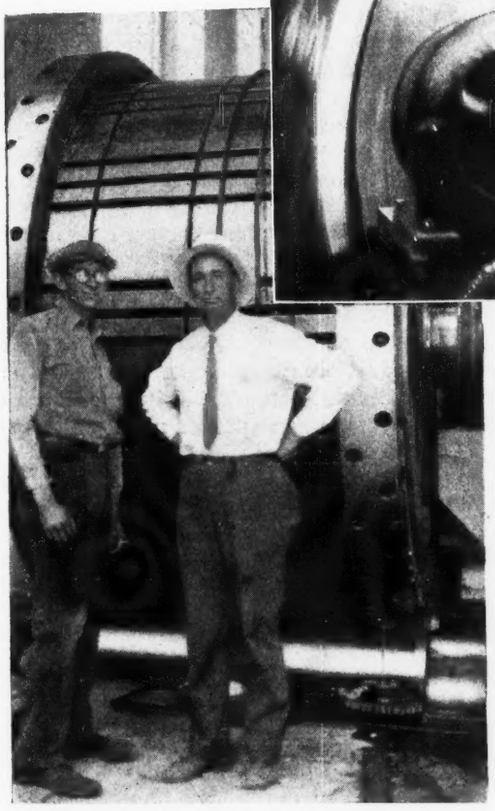


Fig. 3 (Above)—One of the rollers was driven by a motor to revolve the rotor



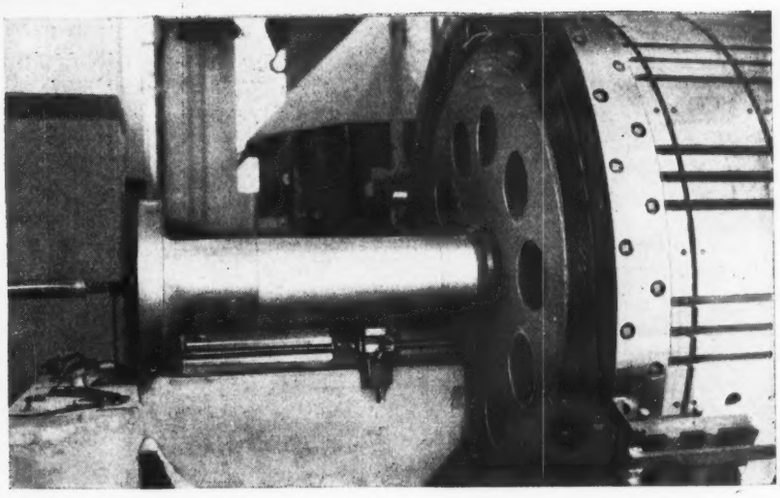


Fig. 4 (Center)—A wooden ring driven by a motor was used to polish the shaft. Fig. 5 (Bottom left)—Rotor in place on the turning rolls. Fig. 6 (Bottom right)—A specially designed steady bearing was used, shown in the lower right-hand corner

preventing any wear. Any inaccuracies in adjustments and surfaces would be transferred through the entire mechanism to the surfaces to be turned, hence the greatest care was necessary in the setup. Oil pressure was maintained by a triplex pump and regulated by individual valves and gages for each bearing, Fig. 8.

Great care was important in all adjustments and alignments to maintain a tolerance of two thousandths for the finished job. A special machine tool was designed for turning the lower end of shaft and facing the coupling, and the bed of a standard lathe was used on the upper end; the lead screws were driven directly by the revolving shaft; a cutting speed of ten and twenty feet per minute was possible.

Before the rotor was placed on the rolls, the chuck rings were adjusted to the known true points. A specially designed frame, bar and micrometer recording feeler were used and the rings brought concentric with these known points by adjusting the screws.

As the rotor assembly was rotated, a check was made with micrometer feelers at the known true points and face of chuck rings as to the accuracy of their adjustment, with satisfactory results. Further tests showed the lower, or coupling, end of the shaft to be sprung 0.045 in. and the upper end 0.110 in. The point of bend in the shaft started about ten inches from the spider on either side. It was apparent that the shaft would have to be straightened to reduce the amount of cut and to prevent reaming of the bolt holes in the coupling.

Spot heating was used, applied by an acetylene heating flame on the convex side of the shaft, the action being to increase the deflection while applying the heat; but on

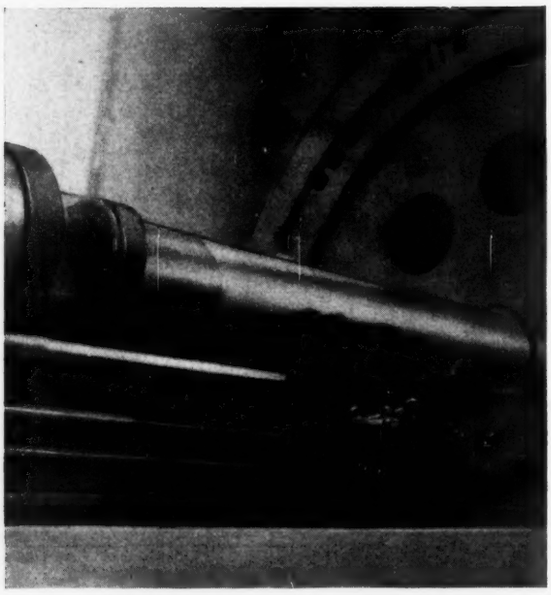


Fig. 7—Lathe tool for turning rotor shaft was mounted on a concrete foundation. Also see Fig. 6

cooling, the action is the reverse and the shaft loses a part of the original deflection.

The first heat was applied over small areas, and micrometer feelers showed the shaft had returned plus 0.010 in., and it was estimated that the temperature of the surface of shaft was under 250 deg. F. Four heats were applied on the flange end and fifteen on the upper end, with the result that the shaft was brought to within 0.002 in. of being straight.

Five kilowatts was required to turn the mechanism, and when 800-lb. oil pressure was used on the bearings, the motor started the load without any apparent effort and with no slippage of rolls recorded.

To prevent creeping of the rotor on the rolls due to the large overhang, also to prevent any possible harmonics, a specially designed steady bearing was used, shown in the lower right-hand corner of Fig. 6. This functioned as a steady rest. A large ball bearing, supported in adjustable pillow blocks to regulate the bearing pressure, rested on the face of each ring chuck and by this means all vibration was eliminated.

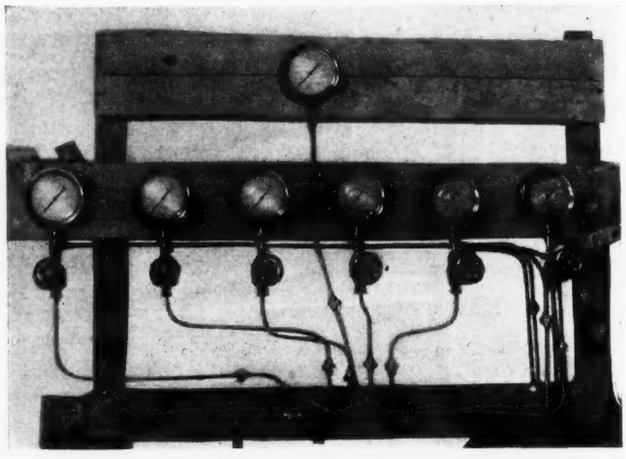


Fig. 8—Gages on turning-roller bearings, on which about 1,000-lb. oil pressure was used

After the shaft had been turned as smooth as possible, a special lapping tool was designed to secure a proper bearing surface. A small motor was mounted on the carriage of the turning tool, being moved laterally by the lead screw. This motor was belted to a wooden pulley bored to fit the shaft and was lined with sheet lead. A thin oil was spread on the surface of the shaft and fine carborundum sprinkled over it. The wooden pulley was rotated at a fairly high speed in the opposite direction from the rotor and the bearing surfaces were given a fine polish.

The rotor was balanced by weighing each polepiece and placing it correctly.

To make the electrical repairs the stator laminations were removed, straightened and reconditioned. All old iron possible was used, but, approximately 50 per cent new iron was required. All new coils were placed in the stator and the polepieces were rebuilt, but it proved practicable to use the old copper after proper repair and conditioning.

Owing to the early and satisfactory operation of this unit, it is believed a record was made. After the work had been finished, the machine assembled and brought up to speed, the result justified immediate loading, and within a few minutes it was carrying 9,000 kw. and within 30 min. was given full load, which continued over a period of four hours.

During this run the machine was free from vibration and there was practically no rise in temperature at either guide bearing. It must be remembered that no run in of bearings was made. The unit has been in operation for several weeks and is functioning better than when new. Several thousand dollars were saved in this work; however, the early and satisfactory operation of the unit meant more than this to the city's Bureau of Light and Power.

POWER PLANT
Development Limited
By Available Materials

By T. Farrance Davey
Assistant Resident Engineer, Stone & Webster, Inc., Long Beach Steam Plant, Long Beach, Calif.

MODERN steam plants offer a wide scope for the ingenuity of the metallurgist, still a few steps behind the aims of the designer, who in the struggle for efficiency has recourse to increasingly higher temperatures and pressures. The weakness of metals as at present developed is only too clearly demonstrated by the accompanying curves showing the effect of high temperatures and resulting creep on strength. This weakness is further aggravated by inherent defects in the material and by extraneous causes.

The inherent or physical defects in order of importance are as follows:

Creep or fatigue under combined loading and temperature, depending upon the composition of the material.

Inclusions of impurities or free material, which weaken the grain structure and are themselves susceptible to corrosion.

Too large a grain size and lack of homogeneity due to imperfect heat treatment and annealing.

Unrelieved strains due to manufacturing processes and shrinkage.

Blowholes in castings and imperfect work in forged material.

Extraneous causes of failure may be classed as follows:

Gaseous causes: Oxidation upon dissociation of steam; hydrogen embrittlement of the metal under the attacks of certain gases; carbon-dioxide corrosion on the steam side of the plant; included air causing oxidation in circulating systems where not removed by deactivation or deaëration processes; cavitation, impairing efficiency and setting up corrosion and electrolysis in condensing and heating equipment and air pockets causing overheating and pitting of heater tubes; acid fumes present in draft systems and the atmosphere; air from transformers not rendered inert by the removal of oxygen to prevent combustion.

Fluid causes: High velocities due to wiredrawing or throttling; grit in lubricants and other fluids; oil in condensate; sludge and water in lubricating oils; impure waters and active chemicals causing metals to go into solution; electrolysis; oil in circuit breakers not dehydrated to preserve its insulating properties; grounded electric currents causing corrosion at the point of grounding.

Solid causes: Deposits from feed water in heaters, evaporators, boilers, boiler and superheater tubes giving rise to overheating, pitting and corrosion; rime on insulators on transmission lines in sea air.

Sources of failure due to design and erection: Stresses arising from expansion and contraction should be provided for by generous bends, expansion joints and spring supports flexible in three dimensions for heated piping, by rollers for heavy equipment expanding mainly in one direction, such as steam headers, by slip plates for equipment expanding mainly in all horizontal directions, such as turbine generators and attendant condensing equipment. Weakness may be caused by badly designed castings. In erection care must be taken to apply the correct clearances for heated equipment, especially in such close limits as apply to turbine blading. Bearings in horizontal turbine generators must be aligned to allow for the sag of the rotor shaft under its heavy loading and especially now that these shafts are 100 ft. in length in a 100,000-kw. unit. Coupled equipment, where the driver runs at a different temperature from the driven, must be carefully aligned, allowance being made for the difference in expansion under working conditions to prevent wear in couplings. Velocities in water and condenser tubes must be maintained to avoid corrosion. Symmetrical design should be used. Settling in foundations must be guarded against by allowing a sufficient period to elapse for seasoning before the erection of the machinery, and vibrating foundations should be isolated from the floor and the rest of the structure by vibration joints.

Living growths: To prevent trash, fish, and mollusks

Materials of construction used in power plants are the basis of successful operation. No matter how good the design or skilled the operation, unless the materials are suitable in properties and of high quality, failure will result. Therefore, engineers must be prepared to select and employ materials intelligently, making use of the experience of others and of the most up-to-date research results.

from entering circulating water, screens have to be used, and all tunnels must be periodically cleaned of marine growths.

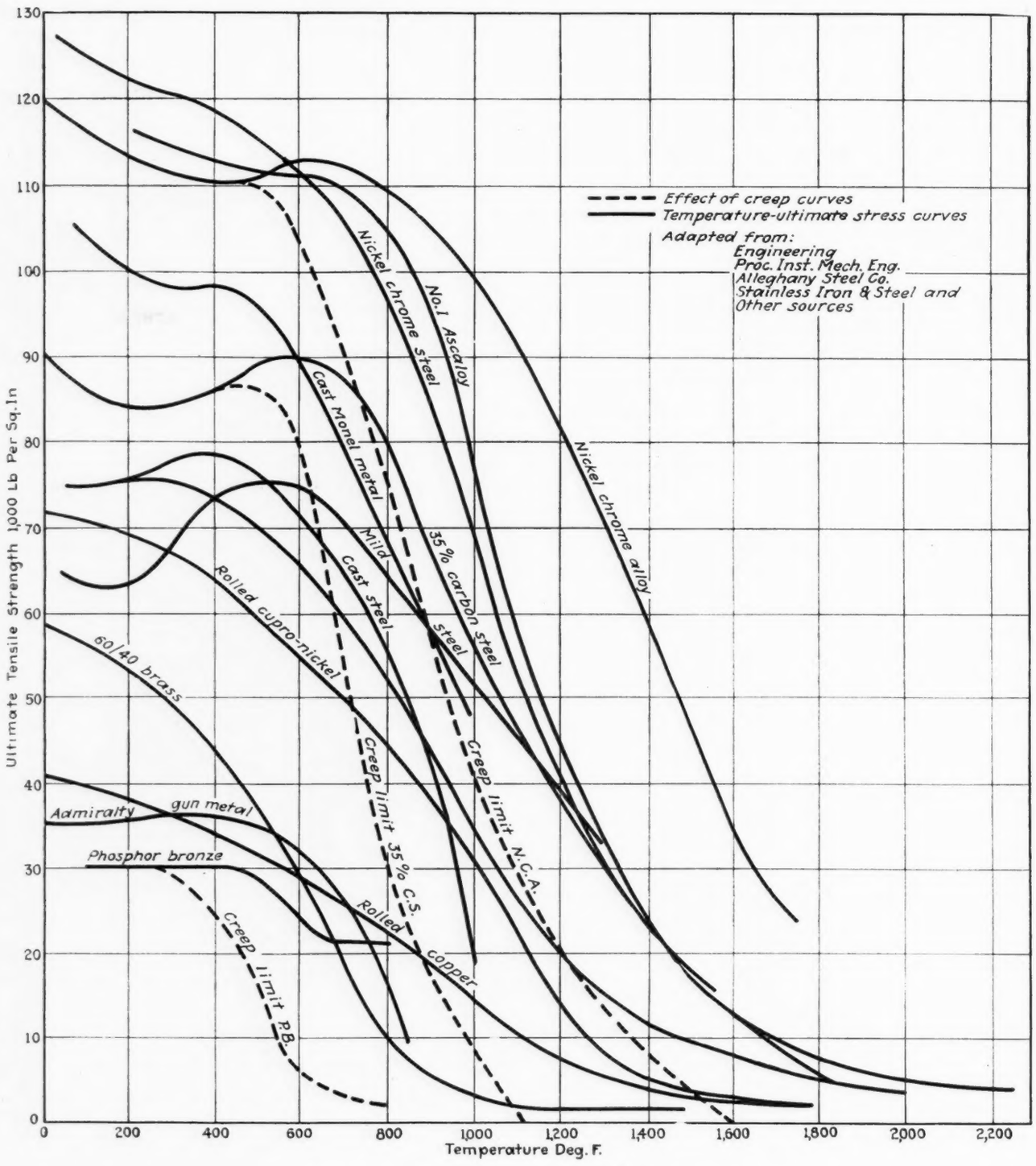
To give an idea of the applicability of various metals for service throughout the plant the following résumé, the result of notes compiled during the design and construction of the Long Beach Steam Plant, is given:

The ferrous materials are products of pig iron either in the form of iron and steel or as alloys, and may be divided into a number of classes.

Bessemer converter steel is often used where open-hearth steel should be used; but it becomes brittle owing to fatigue and is unreliable physically and chemically, and hence should not be used for boilers and tanks.

Open-hearth furnace steel is used for structural shapes, for steel frames for buildings and bus structures; reinforcing bars and wire for concrete; plates for tanks, boiler and heater shells; annealed forged steel for steam headers; semi-steel for elevator sheaves; black sheets for lagging of generators, turbines and fans; tin sheets for fireproof doors; galvanized steel for ventilating ducts; wire chains, cables and ropes, rivets, bolts, nails and fencing.

Forged steel is made into seamless steel pipes by the



Effect of temperature on tensile strength of metals

hot-finish process for high-pressure piping and air preheater tubes, into steam jets, and chests for high-temperature service, and soot-blower tubes in the third pass of the boiler.

Electric furnace steel: In the form of cast steel this is used for main and auxiliary boiler feed and steam fittings, flanges, bodies, yokes, bonnets, gate valves, and drainers for feed-water heaters, steam strainers, turbine casings, turntable pivots, worms and gears. When forged and rolled, it is used for pipe flanges, high-pressure globe valves and springs; and, when drawn, for plow-steel hoisting rope.

Puddling-furnace steel is used for water softening equipment shells, rivets and bolts. As wrought iron it is used for pipe for low-pressure waters, pipe for electrical busbars for outdoor switch gardens, and protecting tubes for pyrometers used up to 1,400 deg. F.

Crucible furnace steel is used for steel fittings for main and auxiliary boiler-feed and steam lines.

Cast iron will vary in carbon and graphite content affecting its resistance to corrosion; and being relatively strong in compression compared with tension, it is used under light internal pressure, as for soil pipes, condenser water-boxes and casings, hotwells, salt-water circulating lines, soot and ash hoppers and chimney caps, and for heavy external pressure as in machine bases, turbine-generator bases and slip plates. Electrically, it is used for grid resistances and electrodes for prevention of electrolysis in condensers.

Malleable castings are used for brackets and miscellaneous duties, as protecting edges of rolling steel doors.

Commercially pure iron, such as Swedish iron, is used for elevator cables and armatures of motors and generators.

In the ferrous and other alloys lies the hope of the metallurgist for the acme of strength under combined temperature and pressure.

Copper bearing steel, owing to its ability to acquire a dense, protective coating that is resistant against atmospheric corrosion, is used for louvers, window frames, grilles, tank tops, in which case rivets should be of the same metal; and, when electric-galvanized, is used for rolling steel doors. Open-hearth, oil-heat-treated alloy steels are used for bolts under high temperature stresses.

Stainless steel is suitable for high-pressure, forged gate-valve seats and rolled spindles, heater drip-pump shafts. Ascaloy is used for turbine blading and baffle plates in boilers.

Chrome-nickel cast iron is used for front plates of gas and oil burners. Nickel and chromium steels are used for valve seat and disk rings for superheated steam. Chromium, plated on steel, or cast on steel ingots and rolled to shape, forms a protective coating against corrosion and erosion. Disaloy, containing in excess of 26 per cent chromium, is used for soot-blowing elements in the first pass of boilers at 2,000 deg. F.

Calorized steel, an iron aluminum alloy with an aluminum oxide formed on the outside at about 1,700 deg. F., will sustain stress under high temperature and is used for soot-blowing elements in the third pass of the boiler at 1,800 deg. F., and is also used for superheater and pyrometer tubes.

Ferro-silicons, such as Duriron and Corrosiron, are highly resistant to acids other than the halogens in the same manner as sand cast iron, but cannot be machined.

The non-ferrous metals and alloys, and alloys with a small percentage of iron, have many uses, some of which follow:

Cupro-nickel is used for turbine blades for superheated steam at high velocities, and for steam nozzles.

Nickel-chromium is suitable for pyrometer protection tubes at 2,000 deg. F.

Muntz metal serves for steam condenser tubes under extremely good conditions, and for tube sheets for condensers and surface air coolers.

Manganese-copper, manganese-bronze and nickel-bronze are suitable for turbine blades for low pressures and velocities, and for parts in contact with steam.

Admiralty metal is used for steam condenser tubes exposed to salt, brackish or polluted waters; surface air coolers for generators; and tubes for precoolers, preheaters, stage and inter- and after-condensers.

Monel metal is used for turbine blades for superheated steam at high velocities, turbine nozzle blocks, trimmings and strainers in contact with steam, small high-pressure gate-valve plugs, bonnet joint gaskets, valve disks, seats, spindles, valves for boiler soot blowers, facing for wedges in boiler feed lines, fittings to drainers from feed heaters, and bulb sockets for temperature controllers.

Copper finds its main use in the electrical field for tubing, busbars, conductors and wire, also for fins on surface air cooling tubes for generators, expansion joints both for piping and for construction joints in concrete, and for rain-water pipes, scuppers, roof flashing and roofing. Bronze is used for impeller-wearing rings and diffuser vanes for centrifugal pumps, steam-jet diffusers, casing for steel shafts on condensate pumps and salt-water sprays, valves for water-softening equipment, and bushings for bearings.

Lining a Steel Stack with Cement

RECENTLY, the Great Western Power Company, of California, lined the two stacks for its new San Francisco steam plant with material made up of one part portland cement, two and one-half parts silica sand and three parts of firebrick screened through $\frac{3}{8}$-in. screen which was reinforced with 3x3-in. No. 10 gage welded wire mesh. The lining was applied with a Cement-Gun in successive layers until built up to the thickness required. The final coat was given a steel trowel finish and the lining kept moist for a period of five days.

Various precautions that were considered necessary in the application of the Gunite were contained in specifications prepared by McClellen & Junkersfeld, Inc., consulting engineers, New York City, as follows:

An air pressure of not less than 35 lb. per sq.in. shall be maintained at the nozzle and proportionately higher pressures when the mixed material is to be lifted higher than 25 ft. or shot through more than 100 ft. of hose. The nozzle shall be held about three feet from the surface being covered and so that the stream of material is perpendicular to it. Any deposit of loose sand shall be removed before placing original or successive layers of Gunite, and should any sand be covered it shall be cut out. The surface, upon completion, is to be free from mounds and as true to line as the character of the work will permit. Before starting work, the contractor shall have the interior of the stack brushed free of loose scale, heavy rust, grease or other foreign matter.

The portland cement to be used for this work shall conform to the latest standard specification and test for portland cement of the American Society for Testing Materials. The sand used shall be clean, dry and free from all loam, organic or other injurious matter.

The water used shall be clean and free from oil, acid, alkali, scale or other impurities. The pressure of the water must at all times be not less than 20 lb. greater than the pressure on the material.

Drives for

FORCED AND INDUCED DRAFT FANS

With proper volume control constant-speed squirrel-cage motors have advantages over slip-ring type

BY G. C. DERRY*
AND
J. R. DARNELL†

THE increased demand for motors for fan drives is due largely to changes in the method of heating feed water. In central stations the feed water is either heated with steam bled from the main turbines, or economizers are installed. In industrial plants, if electric power is not generated, economizers are often employed for feed-water heating. Even where turbines are used to drive feed pumps, motors, in many cases, are used to drive the fans.

ALTERNATING-CURRENT MORE SUITABLE

Flexibility and the possibility of centralized control are leading factors in the selection of fan motors. Considering speed variation only, the problem can be solved by the use of direct-current motors, but direct current is not available in many plants, and even when it is, the added complications may stand in the way of its use. Briefly, the disadvantages of direct-current motors are: Higher first cost and maintenances, more complicated and expensive starters, and difficulty in building them in large sizes for high speed.

Alternating-current motors may be classified as synchronous, squirrel-cage, slip-ring or wound-rotor and brush shifting (see Figs. 2 to 4). These types will be discussed in the order named except the last which will be passed over because of its high cost and the small number in use in power stations.

In general, the synchronous motor is not suitable for fan drive. If a fan is operated at constant speed, the volume must be controlled by some sort of damper located in the inlet or discharge. This method, while effective in controlling the volume, requires more power than would be needed to handle the same volumes with changes in speed, due to the resistance offered by the damper. The expense involved in excess power bills in some cases, therefore, may be as great or greater than the saving due to power-factor correction, assuming that the synchronous motor is entrusted to an operator competent to control this correction. It is entirely possible for a careless operator to obtain a poorer power factor than with an induction motor.

Speed should be given prime consideration with any type of alternating-current motor selected. For any given motor horsepower, the higher the speed the less the cost, since the number of poles decreases proportionately as the speed is increased. It is advisable, therefore, to select fans that will run at comparatively high speeds. Where operating conditions permit, 1,800 or 1,200 r.p.m. are desirable for forced draft and 900 to 720 r.p.m. for induced draft.

Occasionally, purchasers of fans specify the speed, stating that it shall not be over 1,200 r.p.m. (in some cases not over 900). However, if all bearings are kept properly lubricated, the high-speed motor is much more desirable than the low-speed. When it is realized that a fan must operate at a certain "tip," or peripheral, speed to produce a given pressure, it can be readily seen that if the motor speed must be reduced, the wheel diameter must be increased to maintain the same tip speed. The purchaser, therefore, must decide whether he will have a large fan running at low speed or a small fan running at high speed. In most cases the advantages are in favor of the small fan.

Purchasers will be assured of the best results if they will permit the fan manufacturer to select fans for the highest efficiency, the speed being allowed to remain at whatever nearest motor speed it may chance to be.

DESIRABLE MOTOR CHARACTERISTICS

From the users' point of view the best motor is that having the greatest reliability, suitable characteristics as to starting torque and speed, high power factor and efficiency. The squirrel-cage induction motor usually has these characteristics which, combined with its low price, give it first consideration for fan drives. However, it is at a disadvantage in drawing lagging current, there being almost as much lagging reactive current at no load as at full load. For this reason the induction motor should be as fully loaded as permitted by the "duct characteristic" of the draft system. High-speed induction motors have an inherently higher power factor than those with low speed, and for this reason motor speed should be as high as permitted by the limiting "tip," or peripheral, speed of the fan.

With motor-driven fans torque is highly important and must be considered if the motor is to start its load properly and yet not be underloaded during normal operating conditions. In the speed-torque characteristics of a fan driven by a squirrel-cage induction motor, the horsepower varies as the cube of the speed and the torque varies as the square of the speed.

When a squirrel-cage motor is running at zero load, little torque is required to drive it, but when connected to a fan, if the latter is not unloaded when the starting voltage is applied, full speed will not be reached on the

*Manager, and †assistant manager, mechanical draft department and economizer department, B. F. Sturtevant Company, Hyde Park, Mass.

starting position. This may cause a severe electrical jolt when the motor is suddenly thrown to the running position. If, on the other hand, the damper in the inlet or discharge is closed, the torque required at full speed is approximately 40 per cent of the full-load torque and the motor has no trouble in bringing the fan to approximately full speed on the starting tap.

Fig. 5 indicates the starting torque of a certain induced-draft fan direct connected to a 1,200-r.p.m. multi-speed motor. When the switch is thrown and the fan starts, the torque is 900 lb. at one foot radius. As the fan speeds up the torque is gradually increased and reaches a maximum of 2,600 lb.-ft. at a speed of 1,020 r.p.m. The torque then starts falling off until it reaches its normal full-load value of 665 lb.-ft., which corresponds to 151 brake horsepower on the fan. This point is marked *A*. When the fan is running at 1,180 r.p.m., the motor is operated with six poles. Increasing the number of poles to eight (corresponding to a speed of 900 r.p.m.), the motor acts as a brake and exerts, suddenly, a braking torque of 2,600 lb.-ft., marked *B*. As the fan slows down, the retarding torque increases and reaches a maximum of 4,000 lb.-ft. at 1,010 r.p.m.,

Fig. 1—This induced-draft fan is driven by a direct-current motor

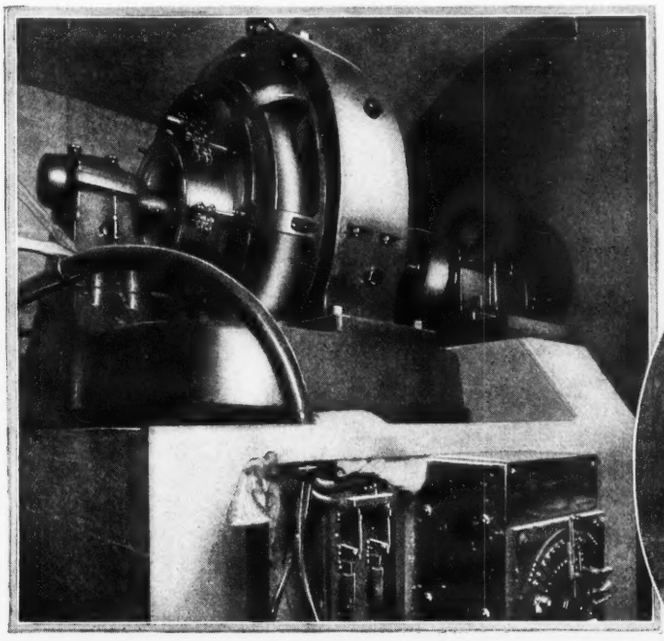
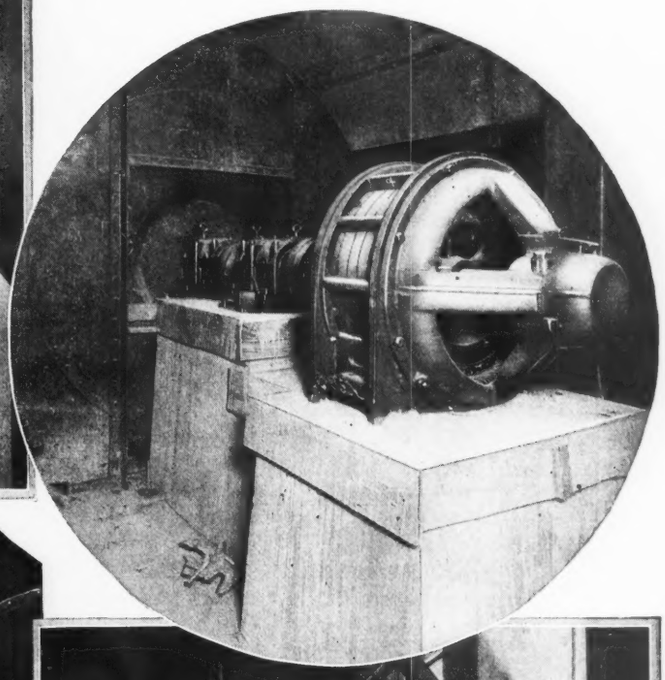


Fig. 2—A constant-speed squirrel-cage motor drives this fan. The volume is controlled with a damper



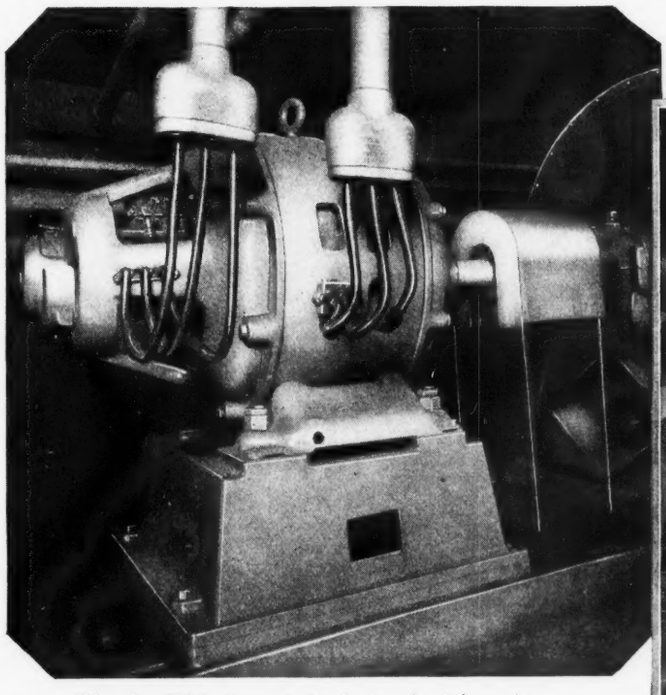


Fig. 3—This forced-draft fan is driven by a slip-ring motor

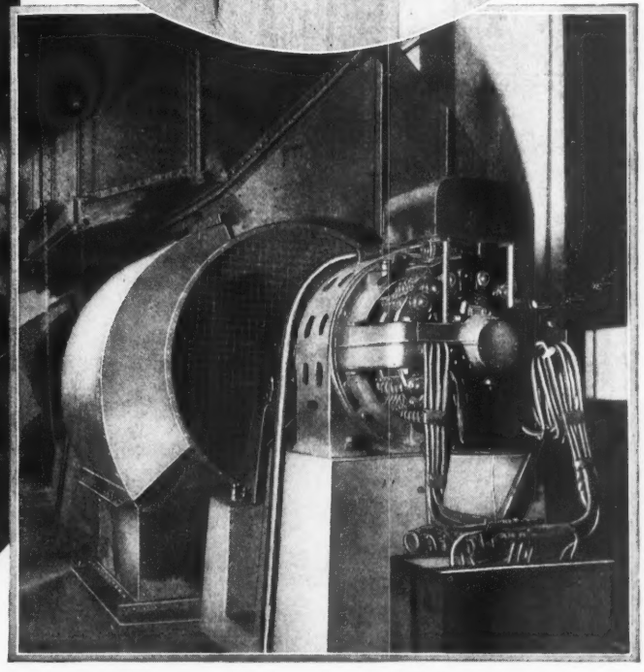


Fig. 4—Brush-shifting motors for fan drives are rare, but two forced-draft fans are shown with this type of motor drive

marked *C*. From this point on the retarding torque decreases and reaches zero at 900 r.p.m. and then swings over to a normal accelerating torque of 320 lb.-ft. corresponding to 63 brake horsepower, which is the fan load at this speed. This diagram shows that the maximum retarding torque is 4,000 lb.-ft. as compared to a maximum accelerating torque of 2,600 lb.-ft. This means that the retarding torque is over 50 per cent in excess of the accelerating torque; and the maximum retarding torque is six times as much as the normal full-speed torque.

Approximately, nine seconds will be required for acceleration from standstill to full speed, point *A*. If the motor is shut off entirely, then it will take 5.5 seconds to slow down the fan and motor from 1,180 to 900 r.p.m. When the number of poles is changed suddenly, it will require one second to bring the speed down from 1,180 to 900 r.p.m.

To relieve this mechanical stress on the fan rotor in some cases, time delay relays are installed in the motor wiring circuit. These relays, however, are expensive and at the same time complicate the electrical

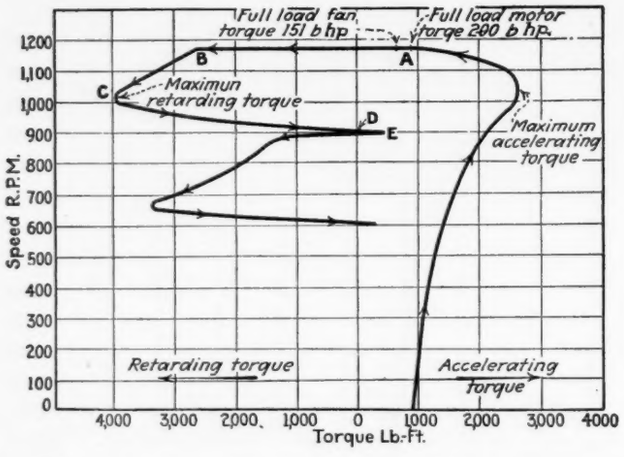


Fig. 5—Here is a study of torque found in the operation of an induced-draft fan

layout and operation, particularly where automatic combustion control is used.

It has been much simpler and more satisfactory to all concerned to design the fan rotor to withstand the increased retarding torque. Where multi-speed squirrel-cage motors are used, fan rotors should be designed for conditions where the maximum accelerating torque may be five times as much as the normal full-load torque and the maximum retarding torque may be 50 per cent higher than the maximum accelerating torque.

Squirrel-Cage Versus Slip-Ring Motors

With one exception, all types of mechanical-draft fans require a higher motor input with squirrel-cage than with slip-ring motors. This exception is a new method of control developed by Sturtevant engineers, in which louver dampers are placed in the inlet of the fan in such a manner that the volume may be controlled with 20 to 30 per cent saving in motor input over that found with the ordinary type of damper regulation, and with substantial savings over slip-ring motor control. This new design thus makes possible sufficient saving in power costs to warrant the investment in a synchronous motor if sufficient horsepower is involved and a power-factor correction is needed.

A brief explanation of the steps leading to the development of this control may be of interest. In order to reduce to a minimum the loss in static pressure resulting from inlet boxes, the new induced-draft fan was built with special spiral inlet boxes designed to guide the gas into the wheel with the least possible

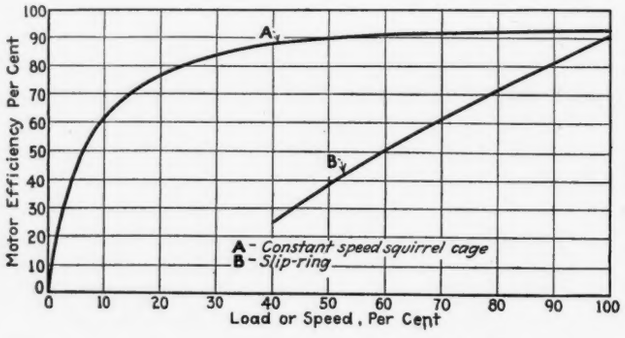


Fig. 6—These curves show typical comparison between the efficiency of constant-speed squirrel-cage and slip-ring types of motors

amount of shock by giving it a forward "spin" in the direction of rotation of the wheel.

It was found, however, that the gas entering the wheel was given so much "spin" that it was traveling faster than the wheel. To reduce this velocity to the peripheral velocity of the wheel, specially designed inlet vanes were provided within the inlet scrolls and evenly spaced around the inlets to the wheel. This arrangement insures that the fan inlets are evenly filled with gas at all points.

In the first design the inlet vanes were provided

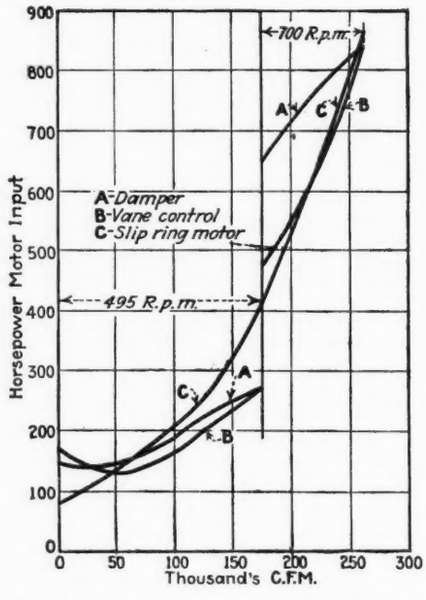


Fig. 7—A typical comparison of motor input with three methods of volume control

solely for the purpose of retarding the spin of the gas. These vanes were in a fixed position and the volume and pressure controlled by varying the speed. Later, it was discovered that if the fans were operated at constant speed, control could be effected by changing the relative position of these vanes, making them open or close by overlapping each other.

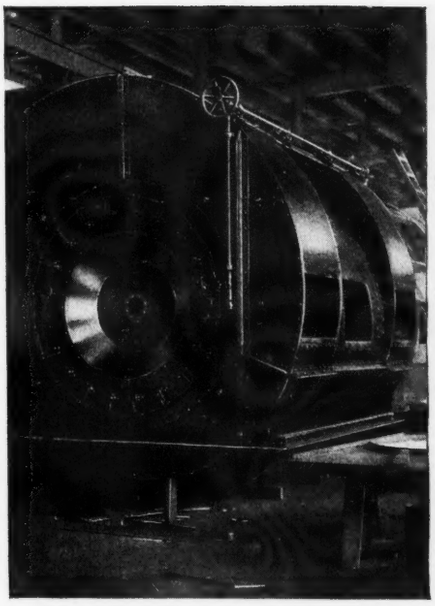


Fig. 8—Movable vanes in fan inlets are opened and closed by worm gear and link motion

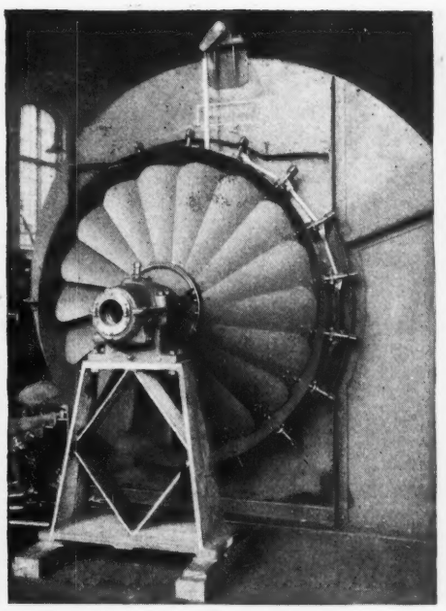


Fig. 9—Forced-draft fan is controlled with V-shaped inlet vanes

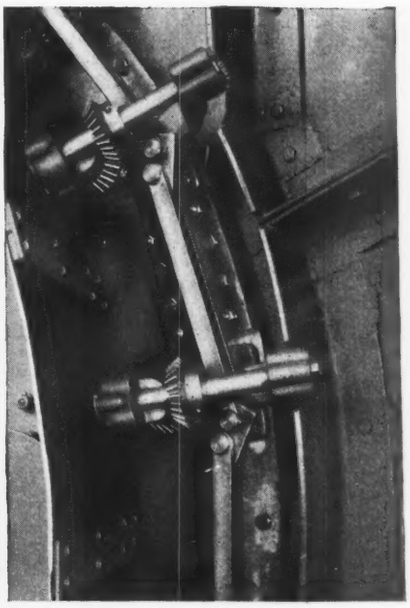


Fig. 10—Vanes are opened and closed by bevel gears and link motion

In Fig. 6 is shown a typical comparison between constant-speed and slip-ring motor efficiency.

Fig. 7 was prepared for a large public utility company, to show the comparison of motor input of a slip-ring motor, two constant-speed squirrel-cage motors using the movable vanes, and the same constant-speed motors with an ordinary damper.

In the majority of cases the volume of gas to be handled at normal load is such that if any fan were employed using a slip-ring motor, the speed at this load would be from 70 to 80 per cent of the full-load speed. For this reason, in order to show the highest saving with vane control over slip-ring motor control, it is advisable to use two constant-speed squirrel-cage motors, one on each end of the fan shaft.

A squirrel-cage motor can be purchased with two windings which will give full and half speed, but at full load the lower speed usually will give a volume less than normal load requirements.

With a slip-ring motor the spiral inlet vanes are stationary, while with a single speed or with two constant-speed squirrel-cage motors, if the movable vanes are used instead of an ordinary damper, the vanes are opened and closed by a link motion actuated by a worm gear (see Fig. 8). The most recent arrangement is to connect this motor to whatever system of automatic combustion control is installed at the plant. The vanes are then opened and closed in exactly the same manner as the ordinary boiler damper.

Movable Vanes Also Used for Forced Draft

It was found that such a fan could be used for forced draft equally well. Since, ordinarily, inlet boxes are not used with forced draft, an arrangement has been worked out whereby movable inlet vanes are applied to the regular cone inlets by placing them radially in the form of V-shaped shutters, directly in front of the cones. This method of vane control is also successful when applied to the fan ordinarily used for forced draft, particularly those with backwardly curved blades. In Fig. 9 these vanes are shown on a large "turbovane" fan. Fig. 10 shows the method of moving the vanes.

A Year's Advance in Equipment

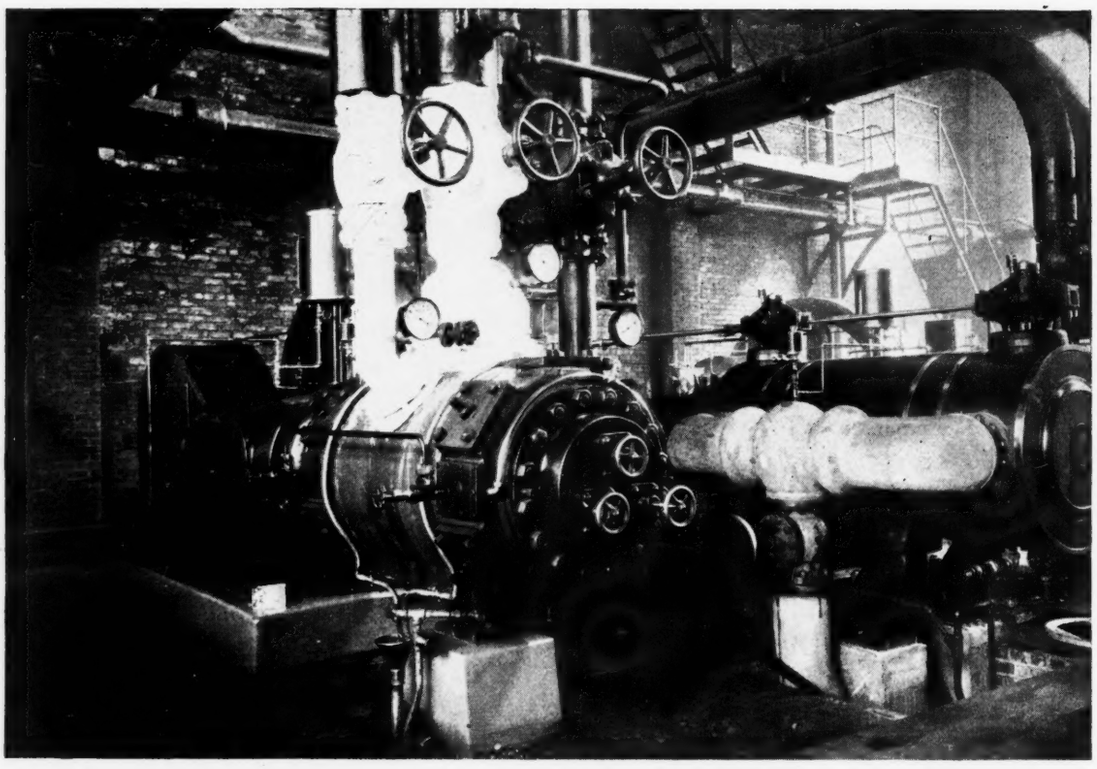
If one is to keep abreast of practice in the power field it is essential that one be well informed on improved equipment that makes such practice possible.

Each week *Power* publishes several pages on "What's New In Power Equipment," but in order to provide a convenient reference for the reader, that will bring him up to date on new and improved things in the field,

January 29 Issue

will be devoted to a review of new equipment that has been described during the last twelve months.

Keep it—Use it—And let us know how you like it.



Clearance Control a Necessity

FOR CONSTANT-SPEED COMPRESSORS

By F. P. MacNeil

WITH the adoption of the constant-speed motor for ammonia-compressor drive, it was impossible to control the pumping power of the compressor to meet economically the varying load demands. This loss of control has proved a serious impediment to economy, but can be overcome by adopting clearance pockets.

With a variable-speed drive advantage can be taken of any drop in temperature of the condenser cooling water to save power. Take the case of a plant in which 50 lb. of liquid ammonia is circulated per minute at a suction pressure of 20 lb. gage. The condenser pressure is 150 lb. gage, and the liquid on leaving the condenser is cooled to within five degrees of the temperature of the water leaving the condenser, or to 80 deg. F. Through a change in the weather the cooling-water temperature drops five degrees and the liquid ammonia leaves the condenser five degrees colder.

If a constant-speed compressor is keeping the temperature at the desired level before the change, after the change in weather the compressor will be too large for the work in hand and will lower the temperatures beyond the desired level. The only recourse the operator has is to reduce the amount of liquid ammonia in circulation. This action is detrimental to economy, for he not only reduces the suction pressure, but also the coil surface in contact with evaporating liquid. He increases the unwetted surface that superheats the vapor, so that the machine runs warmer than it should, thus cutting down the volumetric efficiency.

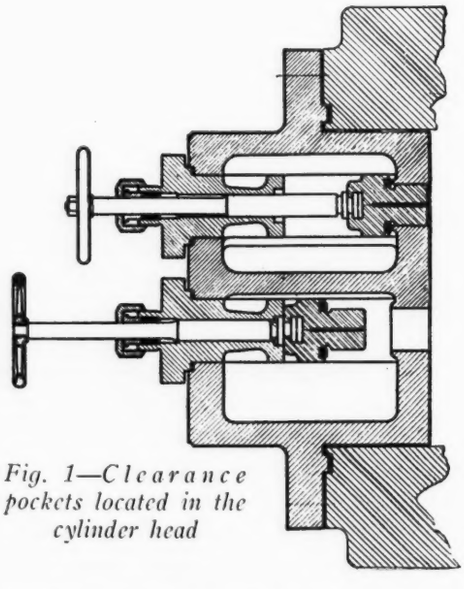


Fig. 1—Clearance pockets located in the cylinder head

Where it is possible to produce the desired amount of

refrigeration at a high back pressure, it is not economical to allow the compressor to do this work at a lower back pressure. The reason for this will be apparent if one consults an ammonia table where it can be seen that as the absolute pressure ratios increase, so the heat involved in the work of compression increases.

High Compression Ratios Impair Efficiency of Compressor

High compression ratios should be avoided, for besides wasting power, they crack the ammonia, carbonize the lubricating oil and seriously impair the volumetric efficiency of the compressor.

A reduction of five degrees in the temperature of the liquid ammonia means that 290 B.t.u. per min. are taken from the amount the compressor has to handle, for less vapor is formed in cooling the liquid to the evaporating temperature. This amounts to one per cent of the volume handled by the compressor. As the head pressure has been reduced nearly ten pounds, the heat of compression has been reduced approximately 5 per cent. The effect of this is to increase the volumetric efficiency about $2\frac{1}{2}$ per cent, equivalent to 10 cu.ft. per min. of pumping capacity. Opening a 4 per cent clearance pocket would have held the temperatures constant and secured for the compressor the economy of keeping the same suction pressure for less expenditure of power.

In order to regain, in some measure, the advantage of a variable pumping power for the constant-speed compressor, some European manufacturers conceived the idea of varying the clearance in the compressor cylinder.

A method used to some extent in Germany is shown in Fig. 2. A smaller cylinder was cast integral with, and parallel to, the main cylinder, having communication with it through ports at each end. Two pistons, traveling on a right- and left-hand threaded rod, were located in the small cylinder. By turning the handwheel the pistons were made to travel toward the ends of the small cylinder, or vice versa, thus diminishing or increasing the clearance in the main cylinder at the will of the operator when the plant conditions change.

Eventually, this idea spread, and while it does not restore flexibility completely, it has rendered the compressor able to meet varying demands more economically than when clearance pockets are not used.

Size of Clearance Pockets

There are many who regard pockets as of doubtful value. It is true that some manufacturers have endeavored to make clearance pockets perform a duty well beyond their scope, at a great sacrifice of economy. These claims have done much to place the clearance pocket in an unfavorable light in the public mind.

Probably the greatest mistake made in designing clearance pockets is to make them too large. A manufacturer builds a 100-ton compressor and then tries to make this machine suitable for 75-ton, 50-ton and 25-ton capacities by using clearance pockets, with the result that the machine is far from economical at the lower ratings. This is not the fundamental idea for which clearance pockets were designed. The notion that they may enable a machine to work economically over a wide range of capacity is a fallacy, and the mistake has been made of connecting an unsuitably large clearance pocket with the cylinder through a port of insufficient area, thus promoting internal friction in the gas. The consequent heating due to high velocity through a constricted orifice increases the pressure against which the piston must work and on the return stoker the orifice reduces the pressure excited by the expanding clearance gas.

One of the foremost arguments used by those opposed to clearance pockets is that a clearance pocket in operation causes a great deal of needless churning of the gas that does not leave the compressor cylinder, thus entailing greater power consumption and loss in volumetric efficiency. This is true only if the pockets are not properly designed and applied.

A point to which undue importance is attached in stressing the imaginary evils of clearance pockets is the contention that the piston will have to do nearly as much work with a pocket open as it does with the pocket closed, owing to the heating of the gas that does not leave the cylinder, but mixes with the fresh charge taken in. This, it is assumed, causes the incoming gas to be heated and expanded, thus reducing the weight of gas aspired. The contention is not based on facts.

Anyone familiar with compressor work knows that the gas in the clearance spaces re-expands and helps to push the piston on the return stroke. The work this clearance gas does is at the expense of the internal energy of the clearance gas, so its temperature must fall. The work done on the gas to compress it into the clearance pocket is, in a great measure, given back to the piston on the return stroke, when the gas re-expands. For a pound of weight of gas circulated, the power to compress it with clearance is practically the same as the power without clearance.

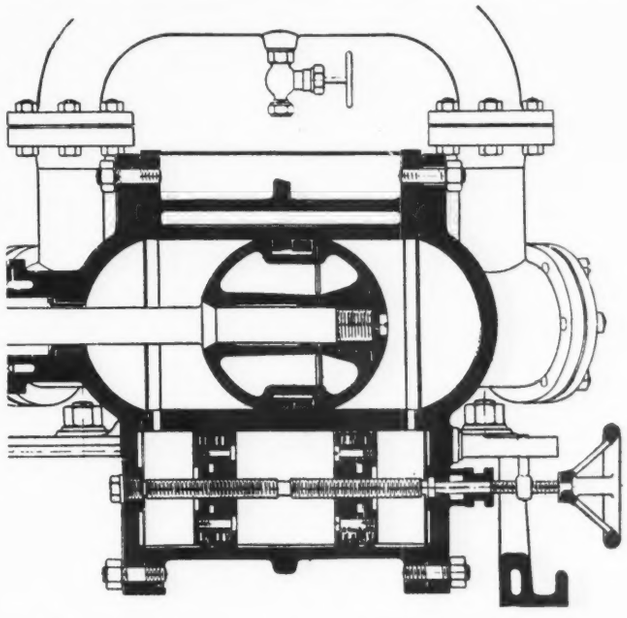


Fig. 2 — An early German clearance-pocket design

An increase of clearance would increase the power consumption if the clearance spaces were water-jacketed, for in that case the clearance gas would lose heat to the jacket and would not be able to return it in the form of energy to the piston on re-expansion.

It is interesting to note how some of these assertions against clearance pockets, when analyzed, contradict themselves. If the gas in the clearance spaces did not cool on re-expansion and we had isothermal re-expansion or anything approaching it, more power would be given back to the piston by the clearance gas than the piston exerted to compress it. It is not possible to have purely isothermal expansion in practice, since the cylinder walls will have to supply heat to the gas to make up for what

it expands in pushing the piston, which would require that the cylinder walls be at a higher temperature, than the final temperature of compression. If the re-expansion were adiabatic, the same amount of power expended on the clearance gas to compress it, would be given back to the piston on re-expansion, and the temperature after re-expansion would be the same as at the start of compression. In practice the re-expansion is neither isothermal nor adiabatic, but a mean of the two processes, although it approaches closer to the adiabatic, especially during the early portion of the stroke.

In the manufacture of ice the constant-speed compressor without clearance pockets presents a vexing problem when fluctuating trade demands require small changes in compressor capacity. Often more capacity has to be cut out than is desired, owing to the awkward sizes of the machines. To get around this difficulty, a late practice has been to install a number of small units, generally of the twin-cylinder inclosed single-acting type. By cutting these out progressively, a gradual reduction in capacity is effected. There does not appear to be much economy in this arrangement, because the aggregate deficiencies of these small units will be quite marked when they are compared to capacity-controlled large units.

How Changing Capacity Affects Clearance Control

In order to gain some idea of how clearance control works out in changing capacity in an ice plant, we may take as an example an ice plant with two compound compressors, 18x12x12 in., making 196 tons of ice daily. The plant uses 2,160 cans and 49,600 lin.ft. of 1¼-in. pipe in the ice tanks; the city water is cooled from 68 deg. to 40 deg. before filling the cans. The suction pressure is 19.6 lb. gage, the condenser pressure 135 lb. gage; the suction temperature at the machine 21 deg. F. and the brine temperature 12.5 deg. F. Under these conditions the power consumption is 42 kw.-hr. per ton, and 114 lb. of liquid ammonia is circulated per minute in the system.

When the demand for ice falls off, by opening all clearance pockets on both machines, 24 per cent clearance to each cylinder, the capacity is reduced to 162 tons daily with a power consumption of 38½ kw.-hr. per ton. The suction pressure is held at 22 lb. gage, the suction temperature at the machine at 33 deg. F., the condenser pressure at 135 lb. gage and 90 lb. of liquid ammonia circulated per minute with a brine temperature of 15 deg. F.

This performance has been repeated numerous times at this plant for runs of as long as four weeks, proving the performance was not an accident.

If these compressors had not been fitted with clearance pockets, the only way to reduce the production of ice would have been to cut down the quantity of ammonia in circulation. On account of the pumping power of the compressor being fixed by reason of the constant speed, the suction pressure would have fallen. Then we would have had a higher heat of compression, a hot compressor with poor volumetric efficiency and more of the ice-tank coil surface acting as a superheater, cutting down still further the volumetric efficiency.

It is safe to say that instead of the power consumption being reduced below 42 kw.-hr. per ton, it would have climbed to around 58-kw.-hr. per ton when the load was reduced.

Peat Fuel for Power Plants

MUCH money and engineering effort are being devoted to the problems of peat utilization in Europe. Since some of our Northern States and large areas in Canada contain great peat bogs that may be regarded as potential sources of fuel supply, it behooves American engineers to follow these European developments closely. This is particularly important since these American peat bogs occur generally in parts of the country that have no coal deposits and where fuel is high priced.

The Soviet government has taken a lead in developing methods of peat production and utilization through its Scientific Experimental Institute of Peat. Russian engineers presented several interesting papers on this subject at the recent World's Power Conference in London. Several of the Russian central electricity stations of 20,000 to 50,000 kw. capacity have burned air-dried peat for some time. Extensions to two of these to give total capacities of 110,000 and 130,000 kw. are now projected.

A novel hopper-feed disk grate for burning peat has been developed by Professor Makarieff, of their research institute. It consists of a number of shafts all rotated in the same direction. Each shaft carries a series of disks with the peat fuel on top. Air under forced draft enters the fuel bed through spaces between the disks. The rotation carries the fuel from front to rear of the furnace as in a chain-grate stoker, and ash is discharged at the rear. This grate is claimed to excel the chain grate in burning peat fuel. It may have possibilities for the combustion of low-grade American lignites and coals as well.

Peat as a commercial fuel is being developed also in Latvia, Germany, Denmark and Scotland. Several processes of peat recovery are in use. Of these, the hydropeat process appears to be gaining favor. In this process hydraulic monitors are used to cut the peat and mix it into a slurry. It is then pumped to drying fields, where it is spread in semi-liquid form and, after partial drying, is cut into block shape by special tractors. It is harvested with about 30 per cent moisture and used thus on stokers.

A new process for artificially drying peat in connection with electrical power plants has recently been developed in Scotland. This may revolutionize the use of peat and make it a commercial fuel in briquet form. These new driers resemble multiple-effect evaporators in general principles of operation and are said to be quite efficient.

These developments are sufficiently substantial to renew the interest of American engineers in the production and use of peat as a commercial fuel.

In passing through the expansion cock from, say, 150 lb. to 15 lb. pressure, the ammonia loses none of the heat contained in it as a liquid. Since the amount of heat a pound of ammonia vapor leaving the evaporating coils can hold is its total heat *H* at the suction pressure, the greater the heat it contains on entering the coil, the less it will pick up. If the liquid ammonia, which, on leaving the receiver is at, say, 85 deg. F., could be cooled so that its temperature dropped to about 10 deg. F., each pound of the liquid on reaching the expansion cock would contain less heat (this being the heat of the liquid at 10 deg. F. in place of the heat of the liquid at 85 deg. F.) and in boiling would have the ability to absorb more heat from the coil walls than before. As a result, the amount of coils per ton of refrigeration would be reduced.

Right Out of the Plant

BOILED-DOWN EXPERIENCE•PASSED ALONG TO THOSE WHO MUST SAVE MONEY, IMPROVE THE PRODUCT AND KEEP THE PLANT RUNNING•

Babbitting Tips

HAVING had several years' experience as an expert metal scraper in the machine and tool field, I should like to add another "babbitting tip" to those contained in previous articles. Instead of covering the arbor or journal of the shaft with paper, preheating or covering with a clay wash, I have found it much better to smoke the journals or mandrels with kerosene.

A kerosene-soaked rag put down in a piece of pipe about 1 or 1¼ in. in diameter, when lighted, will burn with a soot-depositing flame. Small mandrels or shafts may be held over the flame and rotated by hand, thus becoming coated thinly and evenly with a smooth carbon deposit which is practically a non-conductor of heat. The babbitt metal, when poured over this smoked journal, is found to have a smooth and shining surface with almost no blowholes. If the deposit has been made the right thickness, which can readily be learned by experience, no scraping or fitting is necessary.

I have used this method for years in cases where it was desired to babbitt a solid bearing or to cast a nut bearing over a threaded screw. Of course the carbon must be deposited somewhat thicker than in the case of a split bearing, and it is found easy to start the screw loose in the newly poured nut.

Rolla, Mo.

PROF. A. VERN KILPATRICK,
Missouri School of Mines and Metallurgy.

Care of Brushes Influences Machine Operation

THE care given to and the suitability of the brushes largely determine the amount of wear and trouble at the commutators of electric machinery. The brushes should move freely in their holder, but at the same time should be a good fit. Too much clearance may cause them to have two contact positions owing to the movement possible, this being particularly so with reversible motors. Too little clearance causes the brushes to be sluggish in their movement and stick. Brushes that stick in their holder cause sparking and commutator trouble. Recently, a large turbine-driven generator suddenly started to vibrate and to spark at the slip rings. An examination revealed that a stuck brush caused the trouble.

With frequent cleaning closely fitting brushes can be used without sticking, as the usual cause of sticking is dirt. A clean rag moistened with gasoline is an effective way of cleaning brushes. The inside of the holder should also be cleaned. Before these brushes are replaced they should be lubricated on the sides with flake graphite. Only a small amount should be used, just sufficient to work into the pores of the brush and the metal of the holder to reduce the friction. A weekly inspection and cleaning should be sufficient.

The brush pressure on the commutator varies. For ordinary purposes with carbon and graphite brushes one and one-half pound per square inch should be sufficient. High-speed machines will require about two pounds and for traction motors from three to six pounds per square inch. For metallic brushes these pressures should be increased 25 per cent to keep the brushes on the commutator. When the brushes are very small, increased pressure may also be necessary. Brushes making unequal pressures on the commutator cause the current to divide unevenly between them and in the armature circuits. In a wave wound armature the current distribution among the different brush groups of the same polarity is governed by the resistance in the brush circuit. As this resistance is largely dependent upon the condition of the brushes, poor contacts and loose shunts may cause one set of brushes to carry less than its share of total current.

Blackening of the commutator is common with machines driven by gas engines, owing to the corrosive exhaust gases. The best brushes for these machines are the slightly abrasive, electro-graphitic type, which will scour the commutator. With motors exposed to the action of coal, cement and flour dust, I have found the best type of brushes to be natural graphite brushes slightly abrasive. W. E. WARNER.

Brantford, England.

Electrical Machinery in the Gas Plant

ELECTRIC generators and motors housed in the same building as producers or other types of gas plants are subject to insulation and other troubles.

The atmosphere around these plants is always more or less corrosive, and its effect on the insulation is to cause quick deterioration, particularly if the atmosphere is at all damp. It also causes rapid blackening of the commutator segments. Machines for use under these conditions should be totally inclosed and ventilated by fresh air drawn from outside the building.

Where ventilation with outside air is impossible, the windings should be given an additional coat of an acid-resisting varnish, such as anti-sulphuric enamel, applied to the coils over the insulating varnish when they are clean and dry. All exposed surfaces inside the armature and behind the commutator should also be covered with this varnish. The insulation should be frequently cleaned, and any deposit that collects on it should be cleaned off, as it contains corrosive acid.

The machines should be kept dry, and temperatures below 60 deg. avoided, as moisture and low temperature render these gases and any corrosive deposits that may have been formed more active. At times considerable trouble has been caused from fumes drawn inside the armature by the fanning action of the commutator risers. This should be prevented by closing the openings between the risers with duck cloth. When these machines have to stand idle, they should first be given a thorough cleaning and then covered with sheets. E. W. WEST.

London, England.

As the Other Fellow Sees It

WHERE THE MAN WHO AGREES OR DISAGREES WITH AUTHORS OR EDITORS HAS A CHANCE TO SPEAK UP

Flywheel Saves the Motor

IN THE Jan. 8 issue, page 63, the article "Constant-Speed Motors Unsatisfactory on Machine with Flywheel," brings to mind one of my own experiences. A 25-hp. 1,200-r.p.m. induction motor was installed in a lumber mill to replace one of 15-hp. rating, which had proved inadequate to meet the demand for increased output. This motor drove the main saw carriage through a reversible friction clutch. The motor was belted to a countershaft driving a pair of friction wheels that engaged a friction drum. On the same shaft as the drum was keyed a cable sheave which had a one-inch steel cable wound around it and fastened to the carriage so that it could be driven forward or backward at will.

When the mill was put into operation again, it was found that the new motor overheated and slowed down abnormally. An ammeter connected into the motor circuit showed that, when sawing and the carriage traveling about three feet per second, the motor current was fifteen amperes. When the carriage with the log upon it (weighing about 4,000 lb.) was reversed and run back preliminary to the next cut, at an average speed of 10 ft. per sec. the ammeter swung over to 100 amperes for 3½ sec., and the motor slowed down to 920 r.p.m. This simple test revealed that the motor was overloaded because of improper application.

A 700-lb. flywheel three feet in diameter was installed on the lineshaft running at 520 r.p.m. This so improved conditions that the motor current rarely exceeded 60 amperes during reversal of the carriage and then for less than one-half second. The motor now runs at a temperature corresponding to about 75 per cent continuous full load and does not slow down beyond what would be normal for these conditions. W. L. STEVENS.

New Westminster, B. C.

* * * *

Profits of Modern Industry

AREN'T the "cries of profitless prosperity" mentioned in the editorial on page 623 of the Oct. 16 number of *Power* rather ill-founded? Somehow they remind me of the friendly poker game, where, when the game ends, everybody reports losses and no one admits having won. It isn't that the returns are deliberately distorted, it just seems the popular report to make.

Then, too, with the exception of the war period, weren't some of the high profits of the good old days just a little magnified? Accounting methods were not so rigid, depreciation not so carefully calculated, and many a partner worked for his share of the profits. Emphasis was often placed on the unusual profit of a single transaction, and passing by word of mouth, it soon became accepted as the usual profit for all similar transactions—which was far from the facts. Reported highly profitable concerns went along for years until suddenly they went bankrupt, and no one could understand it, although it may often have been due to the simple fact that they did not create a depreciation reserve for new equipment.

With modern accounting methods, with full reserve funds, with working members of the firms drawing salaries for their actual services, with strict control of everything, profits may seem less, but are they? Advances in power generation, transmission and control have certainly done their share for the general manufacturer. Isn't it time we told him frankly that we are not interested in his "cries of profitless prosperity," and that we think him rather ungrateful for the opportunities we have brought him? It really isn't that he is making less profit, it's just that he knows more about his costs and is just a little pessimistic in his reactions to his newly found knowledge. After all, the man who receives no sympathy from his fellows often forgets his supposed ills. Let's stop talking and writing about it.

JOHN F. HARDECKER.

Naval Aircraft Factory, Philadelphia, Pa.

* * * *

Why Scrape a Bearing to Fit?

IN HIS comments on an article by Charles J. Mason in the July 24 issue of *Power*, "Why Scrape a Bearing to Fit?" W. G. Forbes in the November 13 issue seems to think that this is not good practice and feels surprised that Mr. Mason got away with it. From long experience in the erection and operation of large prime movers, I think that Mr. Mason is quite correct in his conclusions; in fact, I feel that the amount of scraping done on bearings is entirely uncalled for.

In 1903 I was in charge of an industrial plant that contained a large high-speed, non-releasing Corliss engine. The bearings of this engine were cast as an integral part of the frame, and in due course it became necessary to rebabbitt the main bearings. While the shaft was sent to the machine shop to have some necessary repairs made to it, the bearings were poured on a jig made for the purpose. No scraping was done except to remove the burrs made in cutting the oil grooves. A full description of the job was published in *Power* at that time.

In 1905, I erected a large vertical Corliss engine in the plant that is now the Bell Telephone Laboratories. The shaft of this engine had two spherical-type bearings. While they were leaded on the journals to see that they had the necessary clearance, no scraping of any kind was done on them, and when the engine was completed and started up, the main bearings operated without trouble.

In 1906, at the plant of the Walter Baker Company, Dorchester, Mass., there were erected two high-speed vertical cross-compound releasing-gear Corliss engines. Running at 120 r.p.m., these engines operated with 175 lb. steam pressure and superheated steam. Their shafts were placed in their bearings without any scraping. After finishing the erection, I operated them for about three months without any trouble.

I have wondered whether Mr. Forbes ever operated a vertical triple-expansion pumping engine. I have erected eight or nine of them in various cities of the country, and only in one case were the bearings scraped. In

passing I might mention that this type of equipment is sold and contracted for on a guaranteed basis of output and efficiency. The erector, in trying to increase his company's bonus, can spend a lot of time and energy fooling with scrapers, red lead and prussian blue and be no better off in the end.

If Mr. Forbes ever saw a fast passenger train stopped along the wayside with a hot journal, he might have noticed that the train crew, after jacking up the bearing, pulled out the old bearing shell, and the old dope from the oil box, put in a new bearing brass that had been babbitt lined over an arbor, filled the oil box with a fresh supply of clean dope and were on their way. The train crew cannot delay a train while they scrape in a bearing.

During the war I was government inspector in charge of the building of turbines for our shipbuilding program at the plant of one of the large electric companies. Skilled mechanics were scarcer than the proverbial "hen's teeth," so that it became necessary to use barbers, waiters, ex-policemen, etc., on the erecting floors. The majority of this equipment, as far as the turbines and gear bearings were concerned, never had much treatment with scrapers, and there were only two or three occasions when bearings had to be scraped and fitted after they had run under full-load test for several hours.

These examples of bearings used without field fitting were all due to accurate machine work done in the shop. As it requires only 0.006 or 0.008 in. for clearance, labor spent in doing any more is just plain fooling, and you usually find after running a short time that the journal has fitted itself better than it can be done by the most skilled mechanic.

J. F. NAGLE,
S.S. El Alba. Chief Engineer.

* * * *

Twenty-Five Years Ago

NOT often do pictures of turbines stir up fond memories, but when the illustration of the first 5,000-kw. Curtis turbine appeared in the Nov. 27 issue of *Power*, it occurred to me that many things about the old turbine were of much value later simply because they were supposed to function and did not.

No one who was not there will ever realize the feeling among the operators when water showed up in the gage glass on the condensate side of the vacuum pump, and no one knew how high it would get before we could stop it.

The original foundation had an opening in one side for access to the step bearing, and many a hard night and day were spent taking out and installing new step bearings, for this machine had a habit of cutting out plates on heavy load. One nearly drowned in hot oil when the bottom plate joint was broken, making it some job to take out the step bearing sleeve, rebabbitt it and reinstall.

On this machine the lower carbon packing consisted of two rings with vertical springs to hold them up against the top flange and down against the bottom flange. They were fastened to the top of the step bearing stool so that every time we had packing trouble it was a warm job to get inside the exhaust opening, under the second-stage wheel as soon after taking the load off as possible in order to remove the carbon rings. Another strenuous pastime we used to have was running around the machine with a lever bar to open by hand the second-stage valves as the pressure increased in the first stage owing to increased load.

It was the idea on this machine to use solenoids to operate a pilot valve, which in turn operated one of the main valves. We kept lead hammers on the operating platform so that if a pilot valve worked but the main valve didn't open, we helped it open by pounding the housing.

Under each valve chest was what was called a first-stage intermediate, and whenever a peculiar noise was heard the first thought was that one of the intermediates was rubbing. We guessed fast as to whether the rub was up or down, then started adjusting the small setscrew to relieve the rubbing. If this did not stop it, the next move was to grab the lever and run around the machine, opening or closing second-stage valves, whichever seemed to relieve the rubbing, and the last resort was to shut down and start all over again. There were so many tricks that seemed peculiar to this machine that when an operator got through a day or night shift without trouble, he was considered a hero.

I have tried as often as five times to get the machine up to speed, and each time failed to get over the critical point of shaft vibration, having to shut down and start over again.

I am sorry I was not at the 25th anniversary meeting, as I would have enjoyed meeting some of the original crew again, and I laugh to myself when I think of the day Mr. Insull was up on the platform when old No. 1 started to rub, and how she could rub when she wanted to!

CARL WILDEY,
Chicago, Ill. An old operator

* * * *

Facts or Fancy?

I READ with interest the editorial in the Dec. 25 issue which decried the argument, evidently advanced by a member of the electric utility family, that it does not pay to modernize industrial power plants because industry cannot afford the necessary capital expenditure. This same argument has also been used in connection with the proposed construction of new industrial plants.

An illustration of what can be done in financing new construction is given in the article on the Gates Rubber Company, published in the same issue. By the formation of a separate company the plant construction was financed without obligation to the rubber company, and therefore without requiring capital expenditure by it. Again, in the Jan. 8 issue the article "Combining Heat and Power in a Southern University" tells how the University of North Carolina installed a uniflow-engine-generator set in order to furnish electric energy for light and power. The initial expenditure for this engine under the purchasing agreement was one dollar, the remaining cost to be paid from savings.

In view of such financing possibilities it is difficult to understand how anyone can continue to stress capital expenditure as an argument against industrial plants.

Any generalized discussion of the relative merits of industrial power plants and purchased power justly deserves criticism. It has been well demonstrated that under favorable conditions it is cheaper for a manufacturing establishment to generate its own electric energy than to purchase it, and equally true that under less favorable conditions of process steam use it is better to use central-station power.

It would be well if the electric utilities recognized this and stopped their generalization against the industrial power plant.

C. R. BROCKNER.
Grand Rapids, Mich.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Service Switch Made with Quadruple Break

A NEW polyphase service-entrance switch, known as Noark Quadbreak, has been placed on the market by the Colts Patent Fire Arms Manufacturing Company, Hartford Conn. This switch gets its name "Quadbreak" from being so constructed that the circuit is interrupted at four places. The contacts at which the circuit is broken are indicated in Fig. 1.

One of the circuits is from the service through contacts *A*, the left-hand fuse, the top meter coil, contacts *B*, and to the load. From the load the return is through the two contacts and fuse in the switch's center leg. The circuit through the right-hand fuse is similar to the left-hand.

Increasing the number of breaks in the circuit reduces the tendency to

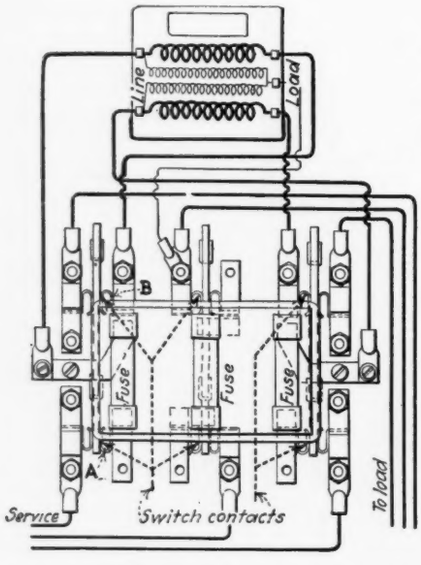


Fig. 1—Diagram of switch circuits

arc at the contacts and increases the rupturing capacity of the switch without breaking in oil, using blowout coils or other devices for quenching the arc.

Each switch element consists of two hard-copper contact plates fastened to a strip of special insulating material. As the strip is moved back and forth by the switch handle, the copper plates open or close the circuit between strong spring contacts. The insulating strip with the contacts moves between blocks of insulating material, acting as guides for the movable member, which, with its contacts, is full-floating and

Fig. 2—Switch cabinet with auxiliary door in the cover

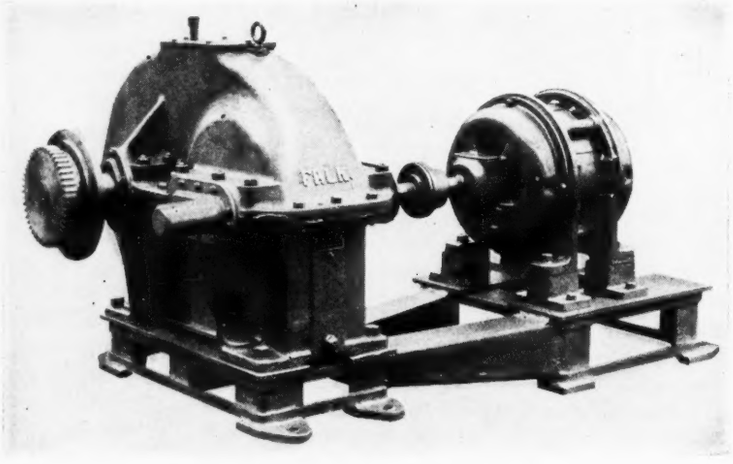
self-aligning between the stationary contacts.

These switches are inclosed in a cabinet. On one style, there is a single cover by means of which the fuses are sealed and are accessible only by breaking the seal and opening the cover. The other style has an auxiliary door in the main cover, Fig. 2, through which the fuses are accessible when the switch is in the off position. These switches have been tested and approved by the National Board of Fire Underwriters.

Improved Herringbone Speed Reducers

INCLUDED in the refinements recently made to the line of speed reducers manufactured by the Falk Corporation, Milwaukee, Wis., is the use of welded steel motor beds, and any unit may now be obtained with this type or with a cast-iron bed. Several sizes have also been added to the line. These include four single-reduction, three double-reduction, and three triple-reduction units, also nine sizes of single-reduction units with vertical centers, making a total of 48 different sizes. The speed ratios are as follows: Single-reduction units of both horizontal and vertical center types, up to 10 to 1, double-reduction units from 10 to 1 up to 70 to 1, and triple-reduction from 70 to 1 to 300 to 1.

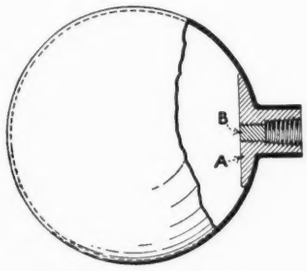
Alloy steel shafts are now used to withstand heavy shock loads and sprocket pulls. The pinions used are heat-treated chrome-vanadium steel forgings. The larger gears are made of a special gear material. The airplane-type sleeve bearings have been retained. Certain of the new types of reducers included in this line will be described in an early issue.



Speed reducer and motor with welded steel base

Ediplate Float Made by Electrodeposition

WITH a view to overcoming the difficulties inherent in floats made in two parts which are soldered or otherwise joined together, the Ediplate Corporation, one of the T. A. Edison Industries, of Orange, N. J., has brought out a one-piece



Float made from one continuous piece of impervious metal

float manufactured by the process of electrodeposition.

The float shell is built up upon a plastic core with which is incorporated the spud connection casting or forging *A*. Thus an intimate solderless bond is secured between the spud connection and the float shell, and the shell itself is one continuous piece of impervious metal. On completion of the electrodeposition operation the plastic core is melted out through an opening at the base of the spud connection, after which this opening is sealed with a plug *B* of the same material as the spud. The float is now reinforced by further plating in the zone adjacent to the spud connection, where the severest stresses in actual service may be expected.

It is pointed out by the manufacturer that this process, obviating the necessity of soldered or brazed joints, leaves no point for the setting up of electrochemical attack and provides a product that will stand abuse in service without strain due to the absence of joints and due to the fact that the spud and float shell are substantially one integral piece of metal.

At the present time these floats are available in copper, nickel-plated copper and nickel-chromium plated copper for working pressures of from 25 to 300 lb. Spherical sizes are available in $\frac{1}{2}$-in. diameter ranges from 3 to 5-in and in one inch diameter ranges from 5 to 8-in. It is announced that other sizes will soon be added to the line and that nickel floats will be available for working pressures higher than 300 pounds.

Oval Tube Air Heater with Removable Tube Sections

THE use of oval tubes to provide a more effective surface for heat transfer, use of metal-to-metal joints without the packing, and sections that are removable from either side without disturbing either the gas or air passages are important features of the air heater recently brought out by the Shaw-Perkins Manufacturing Company, Pittsburgh, Pa. Fig. 1 shows an assembled unit of ten sections, and Fig. 2 shows a section being removed from the side.

In the heating elements the oval tubes are welded in steel-plate headers formed to give a sliding and sealing surface on guide rails in the housing. The elements are made in four header sizes, of ten different lengths each. This provides a wide range in heater dimensions and capacities and makes the heater readily adaptible to practically any plant requirement.

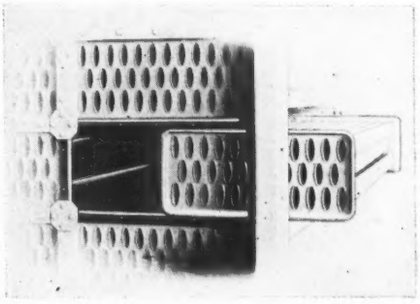


Fig. 2.—Heating elements are removed from the side

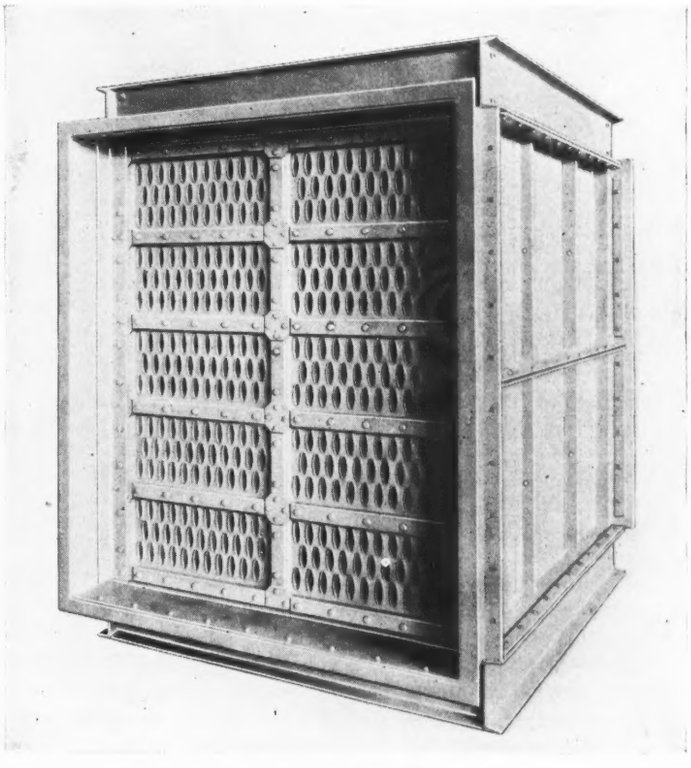


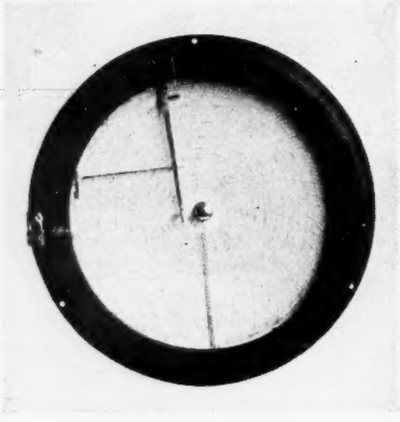
Fig. 1—Assembled unit of ten sections

From a study of the illustrations it will be clear that the use of oval tubes placed in a staggered position, as shown, causes the gas to sweep the entire surface of each tube, and dead pockets, created through sudden changes in direction of flow, are thus obviated. Also, this shape of tubes causes the air passing through it to be confined close to an extended area of hot metal. This tube arrangement also permits the more effective use of the soot blower in keeping the tube surfaces clean.

As shown in Fig. 2, each section is readily withdrawn from the side by removing the outer casing. The sections slide on guide rails at each end. They are locked in position and sealed gas-tight by clamping the flanged lip on the headers to a rounded surface on the guide rail by means of bolted clamps or channels, the inner tapered face of the channels forcing the lip flange on the headers tightly against the guide rail. Provision is made for expansion, longi-

tudinally, by permitting the assembled headers to float in the main frame at one end, with the dished shape of the headers absorbing any local strains.

The heater is adaptable to a variety of uses, including preheating of combustion air for boiler furnaces, heating of air for industrial drying and baking operations and other similar services.



Round-case recorder

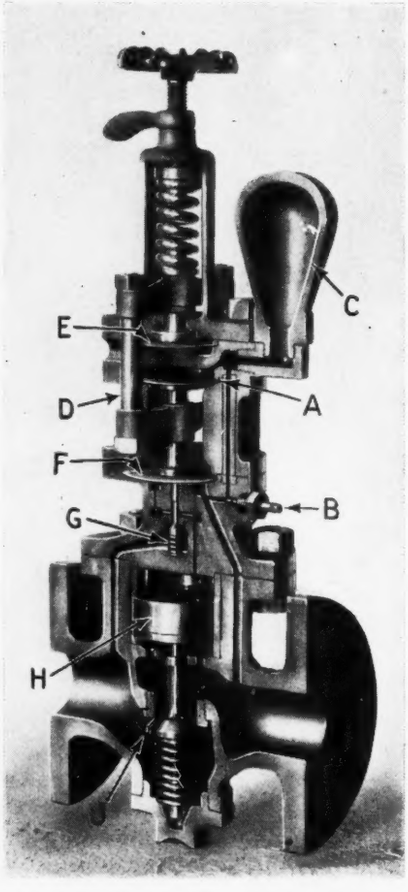
Flush-Type Round-Case Recorder

THE thermostatic system of this flush-type round-case recorder, which is designed especially for power-plant use, may be either vapor tension, gas filled, mercury or compensated mercury filled. The recorder has a full-size 10-in. chart and a pen travel of 4¼ in. It is also furnished with one to four pens for recording temperatures or pressures. The instrument is manufactured by the C. J. Tagliabue Manufacturing Company, Brooklyn, N. Y.

Improved Leslie Pump Regulator

DESIGNED especially to meet the requirements in steam-turbine-driven pump service and for maintaining constant high discharge pressures from reciprocating pumps, the Class PN pump regulator illustrated was brought out by the Leslie Company, Lyndhurst, N. J. It embodies the important features of the Class P regulator described in the Sept. 11, 1928, issue, with a few modifications in design, which serve to make the regulator stable under any load condition. The essential changes in design are the addition of the diaphragm *A*, needle valve adjustment *B* and the steam chamber *C* with the necessary interconnecting passage in the valve bonnet.

As pointed out in the description of the Class P regulator previously referred to, one of the important features of the regulator is the elimination of stuffing boxes on any moving part. This is accomplished by the use of the diaphragms clamped between flanges in the valve bonnet and transmitting the movement from one diaphragm to the other by means of exterior crossheads, as at *D*. This construction tends to eliminate all internal friction in the regulator and to make possible a quick and positive



View of regulator in section showing working parts

action under all pressures and load ranges.

The discharge pressure of the pump is connected to the chamber below the diaphragm *E*, and the movement of this diaphragm, in response to any change in the liquid pressure, is transmitted to the diaphragm *F* which in turn opens or closes the pilot valve *G* controlling the amount of steam admitted to the top of piston *H* attached to the main steam valve *J*. The passage of the steam from the inlet side of the main valve through the pilot valve to the piston *H* is clearly shown in the illustration. The diaphragms *A* and *F* are subjected to the pressure on the discharge side of the main valve in opposite directions, thus the force exerted on these two diaphragms is equalized under steady conditions.

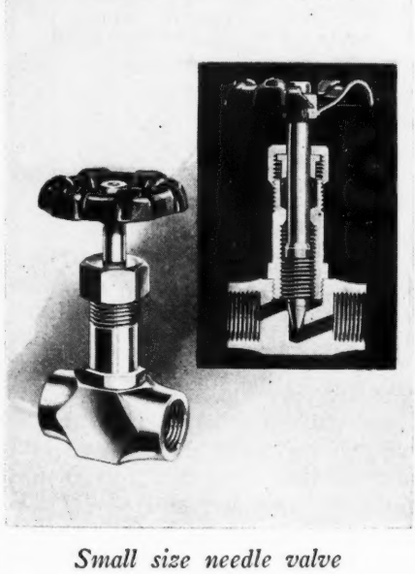
By adjusting the needle valve *B* the equalization of this pressure is delayed and this action, together with the additional expansion space provided by the steam chamber *C*, serves to eliminate any tendency of the governor to hunt with sudden changes in the load on the pump or the amount of steam admitted through the main valve *J*. Results of recent authoritative tests carried out with this governor show less than two-pounds variation in water pressure over a capacity range from 500 to 5,000 gal. per hour.

The Class PN regulator is designed to maintain pump discharge pressures at any point within the range of 15 to 450 lb. It is all bronze, suitable for 300 lb. working steam pressure and 550 deg. total temperature. The regulator is available in standard pipe sizes from ½ to 2½-in. inclusive.

Needle Valves for Small Lines

A TYPE of needle valve particularly suitable for small refrigerating lines, oil-burner controls and measuring devices of other instruments where the control of liquids or gases is required is illustrated.

The valve is made of bronze and can be had in both angle and globe types. It is put out by the Pratt & Cady Division, Reading Steel Casting Company, Bridgeport, Conn.



Small size needle valve

Wide-Range Mercury Element Draft Gage

TO MEET the demands in the way of draft measurement imposed by the present tendency toward larger steam generating units using smaller economizers and air preheaters, the Ellison Draft Gage Company, 214 West Kenzie St., Chicago, has extended its line of vertical pointer draft gages to include a number of models having ranges from 10 to 50 inches.

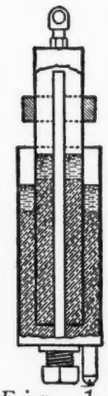


Fig. 1—Detail of mercury element

The unusually wide range has been made possible with practically the same size of instrument as used for the lower ranges, by the employment of a mercury element in place of the water element generally used.

The instrument is of unusually substantial construction, with the complete movement suspended on hardened steel edges and so designed and counterbalanced that the pointer moves in a vertical straight line and the graduations are equal to all points.

The operating mechanism is a 1-in. diameter steel bell floating in a $1\frac{3}{4}$-inch well filled with mercury, as shown in detail in the illustration. Oil is used on the top of the mercury to minimize the adhesion. The gages are arranged for flush mounting and for grouping on a panel.

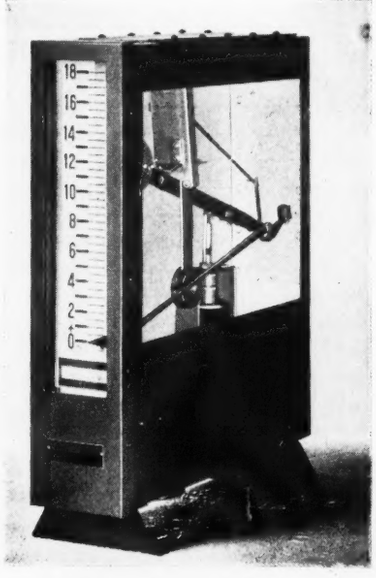
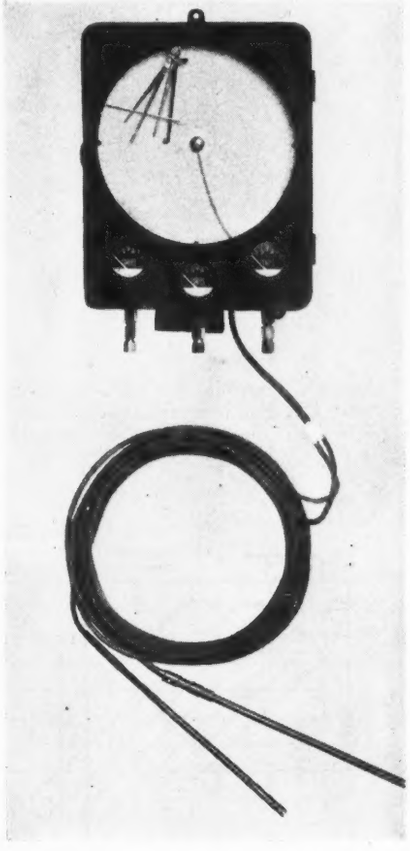


Fig. 2.—Gage with side cover removed to show operating mechanism

Recorder Controller in Single and Double System

THE illustration shows a new square-cased recorder controller brought out by the C. J. Tagliabue Manufacturing Company, Brooklyn, N. Y.

The instrument is furnished in the single or double system, one bulb only being required for each system for controlling and recording the temperature. The thermostatic system of the meter, consisting of the actuating element, bulb and interconnecting tubing, may be either vapor, tension, gas filled, mercury, or fully compensated mercury filled.



Controller with sensitive bulbs and interconnecting tubing

An important feature of the meter is the addition of a flapper valve by means of which throttling control or "on and off" may be had. The instrument is set for the desired temperature by means of an adjustment knob on the outside of the case. All the gages are on the inside of the case and are visible through glass windows in the front cover. The instrument is equipped with a full size 10-in. chart, with a pen travel of $4\frac{1}{4}$ inches.

Improved Duct Elbow With Curved Guide Vanes

BASED on the results of research by the General Electric Company, which showed the superior efficiency of a square-cornered elbow for duct systems, (when fitted with curved turning vanes), as compared with the conventional round one, the Connery Company, Philadelphia, Pa., has made available a duct elbow embodying these improvements as illustrated herewith.

Square elbow with guide vanes more efficient than round one

The studies made indicated that the conventional elbow will have its resistance to gas flow reduced 10 per cent by replacing the rounded outer corner with a square corner; the loss of pressure in the case of a square duct being given in one case as 1.54 times the velocity head and in the other case as 1.36 times the velocity head. This pressure loss was further reduced by fitting a number of short curved guide vanes along the diagonal of the square right-angled turn.

The studies also indicated that by adding blades in a square elbow similar to those shown in the accompanying illustration, any bend can be made to give the highest efficiency. The blades tend to give minimum turbulence and flow area reduction, and since the blade area is small compared to the duct dimensions, the surface friction is but slightly increased.

In the duct shown, guide vanes bent to 90 deg. on approximately a 12-inch circle have been incorporated in a standard square-cornered air duct elbow.

FROM AMONG THE READERS'

Conducted
By
L. H. Morrison

Design of Large Flue Tubes.—*How are flues of large diameter strengthened to resist collapse?* C. M. G.

Flues such as furnaces of Scotch marine boilers are often made corrugated so that the corrugations will resist the collapsing tendency. Sometimes the furnace is made in sections of a U-shape, which, when riveted together, form a flue; in this case the flanges of these members support the flue.

Increasing Capacity of an Engine.—*How would you increase the horsepower of an engine if you could not raise the steam pressure?* A. L. B.

Lengthen the cutoff of the engine so that it takes steam for a greater period in its stroke. Just how this could be done would depend on the type of the engine.

Calculating Horsepower of Steam and Gasoline Engines.—*An engineer stated that gasoline engines are not rated on the same horsepower basis as is a steam engine. As a horsepower is always the same, why is not the same method followed?* R. R. B.

The engineer is correct; two different formulas are used. For automobiles and similar gasoline engines the rating is on the S.A.E. formula: Brake horsepower $= \frac{B^2C}{2.5}$, where B is the cylinder bore in inches and C the number of cylinders. This formula is based on a piston speed of 1,000 ft. per min., and a brake m.e.p. of 67.25 lb. per square inch.

For steam engines the formula is: Horsepower $= \frac{PLAN}{35{,}000}$, where P is the mean effective pressure in pounds per square inch, L the piston stroke in feet, A the area in square inches of the cylinder bore and N the number of working strokes per minute.

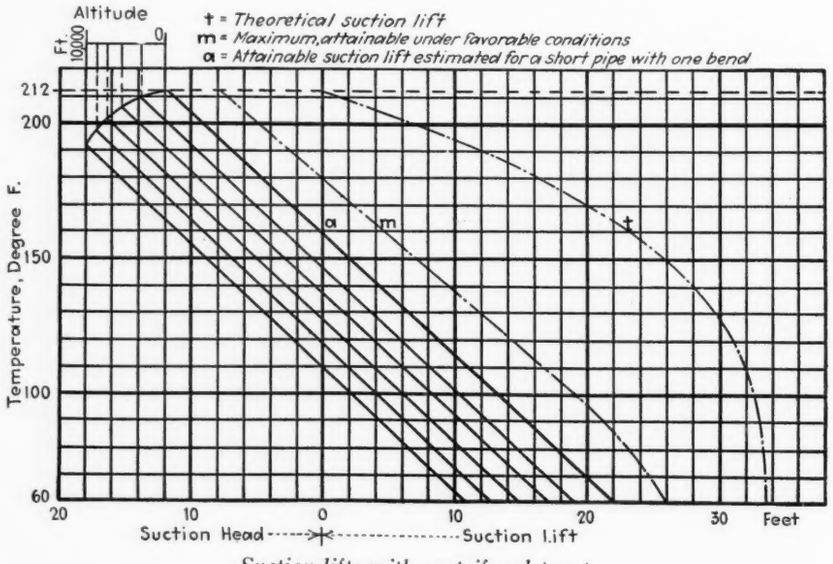
Steam Consumption with Increased Pressure.—*Our boilers are operated at 80 lb. pressure, and as the boiler inspectors will permit 100 lb., we are thinking of raising the pressure if it will reduce the consumption of our engines.* W. J. B.

Broadly speaking, you will use less steam at 100 lb. pressure than at 80 lb. pressure to handle a given load on the engine. This means that under ordinary circumstances you will save coal by operating the engine at 100 lb. boiler pressure.

However, if the load is light so that the engine has a very short cutoff, the additional condensation by reason of the greater number of expansions of the steam in the cylinder, may be such that the engine will actually use more steam at 100 lb. pressure than it would at 80 lb. pressure. With 80 lb. pressure the cutoff would be longer and the number of expansions would be less, consequently the amount of cylinder condensation would be less than with 100 lb. boiler pressure. As a general principle, however, it is more economical to use the higher steam pressure.

Suction Lifts With Centrifugal Pumps.—*What is the greatest suction lift with which one should expect a centrifugal pump to function?* C. R. L.

The total possible suction lift, which includes the friction loss due to water velocity, elbows and valves, depends on the temperature of the water and the altitude. From the chart, prepared by the Aldrich Pump Company, it will be seen that at sea level and with 150 deg. water the attainable suction lift is 2 ft., while the maximum under the most favorable condition is 7 ft., although the theoretical lift is 26 ft. At an elevation of 10,000 ft. there must be a positive suction head of 9 ft. with 150-deg. water, but a suction lift of approximately 10.5 ft. is practical with 60 deg. water.



Suction lifts with centrifugal pumps

Circuit Breaker Contact Heats Excessively. — *Does annealing hard-drawn copper change its conductivity, and will it conduct the same amount of current with the same rise in temperature as before annealing? Our electrician claims that the contact joints of circuit breakers lose their quality of conducting electric current and as a result they heat. These contact surfaces are clear and are considered to be in as good condition as when installed. It would seem that the heating and cooling of the contact takes the life out of the copper and it heats with less load than when first installed.* E. M.

Annealed copper has about 2 per cent greater conductivity than hard-drawn copper. This percentage varies somewhat with the size of wire and the methods of manufacturing.

This, however, has nothing to do with the circuit-breaker contact heating. If the contact is not kept clean, it oxidizes and increases the contact resistance, which in turn causes heating. Excessive heating of the laminated part of the contact draws its temper and a poor contact with excessive heating is the result, no matter how clean the contact surfaces may be.

Even if the contact pressure is correct and the contact surfaces clean, excessive heating may result from the surfaces not being true. If care is not used in cleaning the contact surfaces, they will be worn uneven and no amount of pressure on them will make a low-resistance connection. To obtain a contact that will not heat, the two surfaces must be true, clean and held together over their whole area with sufficient pressure. The lack of one or more of these requisites is probably the cause of the heating.

PROBLEMS

ANSWERS

from Our Readers

THE QUESTION

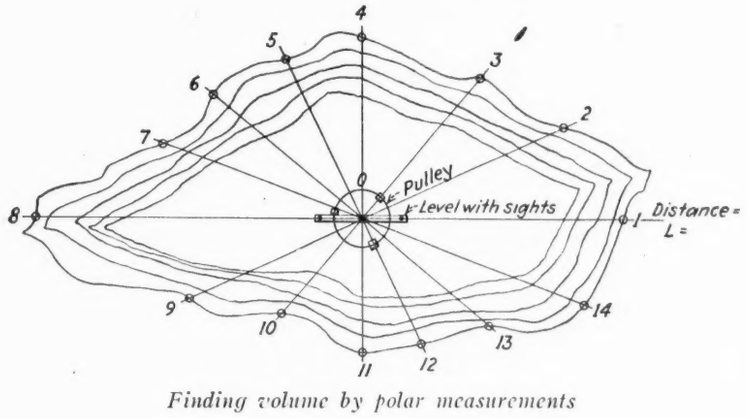
I AM confronted with the task of computing the amount of coal in an irregular storage pile. I have no definite idea of how to attack the problem. What is the most practical way to measure this coal?

W. B. D.

IT IS to be assumed that the ground in the coal yard is fairly level. Coal dropped from the unloading machine usually takes the form of a prismoid with somewhat of a flat top and bounded by an element which follows some irregular base figure, the element itself changing in angle with the base plane from point to point.

It is proposed to make a polar survey of the base area which is the outer irregular line shown above. A cast-iron pulley 20 to 30 inches in diameter is placed upon three wooden stakes driven into the pile somewhere near the center of the top. Either a builder's level or a 2x4 timber having level sights, is placed upon the machined end of the pulley, the pulley rim having been graduated into enough even spaces to bring the rod settings 1, 2, 3, etc., about eight or ten feet apart. An ordinary bamboo pole may be used for the rod and should be painted alternate red or white in one-foot graduations.

An ordinary fishline or other light cord is attached to the pole at the pulley level height for each setting and graduated in feet at the pulley end so as to read horizontal distances from the center of the pulley to each station point. The rod is laid against the slanting side of the pile and a level protractor used to obtain the angle of each element. This angle, together with its distance from the center *O*, is then plotted on a board platform or table to some convenient smaller scale. Nails are driven at each of these points and a representative sample of the coal is shoveled from various parts of the pile onto this layout board until it is filled to the same shape as the large pile. The nails locate the rod settings better after some coal has run over them on the board.



Finding volume by polar measurements

This representative pile is now removed and weighed, and the weights of this and the original will be proportional to the cubes of like dimensions.

A. V. KILPATRICK,
Assistant Professor Mechanical Engineering,
Missouri School of Mines.
Rolla, Mo.

THE method used by me to measure several railway coal piles is outlined as follows: A base line was laid off, and from this base section lines were run across the coal, the spacing being 10, 25 or 50 ft., as the size of the pile indicated.

Elevations were taken on each of these lines to give an accurate section of the coal at each line. These sections were then plotted and the area of the figure determined; this can be done by drawing the section on squared paper and counting the squares if a planimeter is not available.

The average of the adjacent sections multiplied by the distance between them gave the volume of that portion of the pile. For example, if the area of section three was 310 sq.ft. and that of section four 296 ft., then with the distance between them of 25 ft., the volume between the lines 3 - 3 and 4 - 4 was

$$\frac{310 + 296}{2} \times 25 = 7{,}575 \text{ cu.ft.}$$

The volumes between all the lines were found in like manner, and from the sum of these volumes the tonnage was found by dividing by the cubic feet per ton of coal. This varies, but the approximate values of 40 for anthracite, 45 for bituminous and 60 for coke are close enough for practical purposes.

Toronto, Canada. C. R. SCOTT.

A CONVENIENT and fairly accurate way to measure an irregular coal pile would be to construct a miniature of it out of paraffin wax or of mud. It would be necessary to measure the coal pile as to all its dimensions, any irregularities being measured separately, and then to construct the model to scale. When finished off with all its contours corresponding as nearly as possible to those of the pile, the model, if made of wax, could be placed in a bucket and warmed until it assumed a cylindrical shape, whereupon it could be measured and its volume calculated. If mud is used, the model could be pulverized, packed into a bucket, and measured.

It must be borne in mind that the ratio of the volume of the model to that of the original will be as the cube of the ratio of the linear scale employed. Thus, if a scale 1/100 natural size is employed, the volume of the model will be $(1/100)^3$, or 1/1,000,000 that of the original. Consequently, the ascertained volume of the model must be multiplied by 1,000,000 to obtain the volume of the coal pile.

M. F. KNOY.
Lake Charles, La.

A Question For Our Readers

WHAT is surface tension and does it influence boiler foaming?

C. S. R.

Suitable answers from readers will be paid for and published in the Feb. 19 issue.

Recent Publications

THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS GUIDE FOR 1929. Seventh edition. Published by the American Society of Heating and Ventilating Engineers, 29 West 39th Street, New York City. Cloth; 6x9 in.; 900 pages. Price, $5.

IN ORDER to place before the engineers in the heating and ventilating field the most up-to-date and reliable data, the American Society of Heating and Ventilating Engineers annually revise the Guide. The seventh edition of this book contains 34 chapters of text and the catalog data of 170 manufacturers. The new chapters added discuss chimneys, fan-furnace heating, central-heating systems, heat exchangers, laundry, kitchen and hospital equipment, and fans for heating and ventilating. The volume is not the product of one or two men, but of the Society as a whole. The work of compiling and editing was done under the direction of the Guide's Publication Committee, Perry West, editor in chief; W. H. Carrier and C. V. Haynes. Thirty-four subcommittees prepared the technical data, a host of men acted in an advisory capacity and the catalog data section was supervised by Esten Bolling.

INDEX TO A.S.T.M. STANDARDS AND TENTATIVE STANDARDS. Published by American Society for Testing Materials, Philadelphia, 1928. Paper; 6x9 in.; 95 pages. Free on request.

THIS is a combined index to all A.S.T.M. Standards and tentative standards in effect on Sept. 1, 1928. Those standards appearing in the 1928 Supplement to Book of A.S.T.M. Standards are included.

Standards and tentative standards to the number of 542 are listed by subjects, with references to the publication in which the complete standard appears. The index is designed for those who wish to locate any specification or test method in the bound publication in which it appears, and to those interested in ascertaining if the Society has issued any standards on a specific subject.

1928 SUPPLEMENT TO BOOK OF A.S.T.M. STANDARDS. Published by American Society for Testing Materials, Philadelphia, 1928. Paper; 9x6 in.; 195 pages.

SINCE the Book of Standards of the A.S.T.M. is issued but once every three years, supplements are brought out in each of the two intervening years. These supplements contain the standards added during the year of their publication.

The current volume contains several new standards of interest to power engineers. A 105-28 deals with forged or rolled steel flanges for high-temperature service. A 34-28 gives a standard test for magnetic properties of iron and steel. B 61-28 specifies steam or valve bronze sand castings. Brazing solder standards are contained in B 64-28.

Clay firebrick standards for stationary and marine boiler service are given in C 64-28 and C 65-28, respectively. A test for the softening point of fireclay brick is given in C 24-28. Standard terms relating to refractories are defined in C 27-28 and C 71-28.

Friction tape for general use for electrical purposes is specified in D 69-28. The test for steam emulsion of lubricating oils is outlined in D 157-28. Other standards given have some interest to the power plant, but the foregoing are those of most importance.

A.S.T.M. TENTATIVE STANDARDS—1928. Published by American Society for Testing Materials, Philadelphia, 1928. Cloth or paper; 6x9 in.; 932 pages. Price: paper, $7; cloth, $8.

THIS new book of proposed standards, not yet adopted, gives an opportunity for power engineers to criticize and to offer the benefit of their experience before final action is taken. As an A.S.T.M. standard, once adopted, has a great influence on the field, particularly as to materials permissible for use in manufacture, it is advisable for engineers to keep informed as to new standards proposed.

Among the tentative standards in this volume, those listed below are of particular interest to the power field:

A 114-28T. Marine Boiler Steel Plates.

A 95-28T. Carbon-steel Castings for Valves, Flanges and Fittings for High-Temperature Service.

A 120-28T. Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses.

A 106-28T. Lap-welded and Seamless Steel Pipe for High-temperature Service.

E 8-27T. Tension Testing of Metallic Materials.

E 9-27T. Compression Testing of Metallic Materials.

E 15-26T. Radiographic Testing of Metal Castings.

C 38-27T. Test for Resistance of Fireclay Brick to Thermal Spalling Action.

C 71-28T. Terms Relating to Refractories.

D 116-28T. Testing Electrical Porcelain.

D 197-26T. Test for Fineness of Powdered Coal.

D 271-27T. Determination of Sulphur in Coal and Coke by the Bomb-Washing and Sodium Peroxide Fusion Methods.

D 121-27T. Terms Relating to Coal and Coke.

D 27-28T. Insulated Wire and Cable; 30 per Cent Hevea Rubber.

D 296-28T. Cotton Rubber-Lined Fire Hose for Public and Private Fire Department Use.

D 54-24T. Steam Hose.

D 119-28. Rubber Insulating Tape.

In addition to these tentative standards, certain of the adopted standards have had tentative revisions suggested. Such of these revisions as are of interest to the power engineer are: A 84-27, staybolt, engine-bolt and extra-refined wrought-iron bars; A 48-18, gray-iron castings; A 88-24, high-test gray-iron castings; B 44-24, seamless Admiralty condenser tubes and ferrule stock; D 151-23, rubber pump valves; D 271-27, laboratory sampling and analysis of coal and coke.

DISCUSSION OF THE NATIONAL ELECTRIC SAFETY CODE, to accompany the fourth edition of the code, has just been issued by the United States Bureau of Standards, and is designated, Handbook Series of the Bureau of Standards No. 4. This discussion deals with each rule and gives its object, scope and the consideration to be taken into account when applying the rule. The factors that influenced the formation of the rules and why the rules are necessary, are outlined. This discussion includes rules covering methods of protective grounding of circuits, generating equipment, lightning arresters, lines and utilization equipment; rules for the installation and maintenance of electric supply and communication lines; rules for the installation and maintenance of electric utilization equipment; rules for radio installations. Copies of this discussion can be obtained from the Government Printing Office, Washington, D. C. Price, $1.

HYDRO-ELECTRIC AND WATER POWER DEVELOPMENT IN CANADA. — The Dominion Water Power and Reclamation Service of the Department of the Interior of Canada has issued the annual review of hydro-electric and water power development in Canada during 1928. The statement shows that the activity which has been so evident in recent years has been fully maintained, and the amount of water power now under construction and projected indicates that the high rate of increase in developed power will continue for some years to come. Copies of this bulletin containing a brief description of all the more important water power developments under construction in Canada during 1928 may be obtained free of charge on application to the Director of the Dominion Water Power and Reclamation Service, Ottawa, Canada.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

A.S.M.E. Discusses Combustion Control

AT THE regular monthly meeting of the Metropolitan section of the A.S.M.E., held in the Engineering Societies Building, New York City, Jan. 11, R. J. S. Pigott, engineer, Smoot Engineering Corporation, presented a paper on combustion control. Mr. Pigott described some of the earlier types of combustion regulators, leading up to the modern system that controls a complete boiler installation from a master regulator. It was pointed out that the tendency is toward concentrating boiler-plant operation in a central control room, the same as for the generating end of the plant.

To be successful, said Mr. Pigott, combustion-control equipment must be sensitive, stable in its operation and sufficiently powerful to operate under the widely varying conditions found with boiler auxiliary equipment. Attention was called to the fact that tightening down on a throttle valve packing may increase by several times the power necessary to operate the valve. It is also essential that combustion-control equipment be reliable and that it can be handled by the boiler-room employees.

The reduced water-storage capacity in proportion to the size of modern boilers, their high steaming rates and their wide range of operation have tended toward making the control of excess feed-water pressure essential to safe boiler operation and to relieve the water-level regulator from caring for pressure fluctuations between boiler drum and feed line. Mr. Pigott described a regulator that changes the excess feed-water pressure as the square of the boiler rating. Under these conditions the feed-water flow varies approximately as the boiler's rating and the level regulator makes adjustments for the small variations in water level only.

The opinion was expressed that with a modern boiler setting, furnace pressure was no longer an important factor in boiler efficiency. This pressure must be kept within certain limits for safe operation, rather than for its effect on efficiency. Many of the old boiler settings were not tight, and if the pressure in the furnace was not maintained near zero, there were objectionable leaks through the brickwork.

Some of the advantages suggested for automatic combustion control were: It increases reliability; it takes care of the water level; the operator is released to give more time to keeping the boilers operating at their best efficiency; the morale of the operators is improved; the plant is operated at a higher average efficiency than by hand control. With regard to the latter, it was pointed out that automatic control can not obtain any higher efficiency than can be had with good manual operation. It will, however, obtain a high efficiency more constantly than manual control, as the former is on the job 100 per cent of the time. Cases were cited where automatic control took care of heavy load swings without any difficulty, when before its installation the operator had in a number of cases, allowed machines to kick off the system.

WELDING is not stumped either by the size or the oddity of the job. Here is a Crane double lateral water suction fitting for a paper mill. The job weighs 2,200 pounds.

New Canadian Project at Stave Falls

A hydro-electric expansion program involving an expenditure of approximately $8,250,000, necessitated by the increasing industrial activity taking place in Vancouver, B. C., has just been outlined by W. G. Murrin, president of the British Columbia Electric Railway Company, and includes another hydro-electric project on the Stave River at Ruskin and an enlargement of the development which is already under way at Bridge River.

The initial installation at Ruskin, according to Mr. Murrin, will develop 43,000 hp. in one generator, but foundations will be laid for another generator of the same size which can be put in at any time. The first unit is scheduled for completion by the autumn of 1930, in time for the peak load of 1930-31. Situated three and a half miles below Stave Falls, the new plant will operate on a head of 125 ft. as compared with 115 ft. at Stave Falls. The dam, on which work will begin immediately, will have a maximum height of 183 ft. and will be 325 ft. wide.

Changes in the Bridge River development, Mr. Murrin stated, will include a large intake tunnel and the use of 220,000 volts instead of 165.000, for transmission.

Spot * News

THE COLDEST PLACE IN AMERICA *will not be in Alaska but in Texas, when the United States Bureau of Mines finishes the construction, near Amarillo, of its new helium plant. The climate in the plant will have an average temperature of 300 deg. below zero, at which point all gases but helium have become liquefied and can be drawn off.*

* * *

PEND OREILLE RIVER *in British Columbia is to generate 80,000 hp., according to news of a project which has just been approved by the government of that province. The West Kootenay Power Company is the interested party.*

* * *

THE OPERATING ENGINEER *of the Kansas City Terminal Railway's power plant has established a "farm" at the door of the plant, to relieve the monotony of steel and brick. Being only 20x30 ft. in extent, this farm is worked entirely by the engineer himself in off hours.*

* * *

STEVENS INSTITUTE, *in Hoboken, N. J., is planning a survey of the metropolis, with a view to co-operating with the authorities in the removal of the smoke nuisance. Doctor Davis, president of the Institute, says that a smoke blanket 2,500 ft. thick is preventing the sunlight from penetrating to New York's citizens, who need the health-giving ultra-violet light.*

* * *

GOVERNMENT IN BUSINESS *again puts in an appearance in the Watson Bill, which, if passed, would set up a federal commission to regulate the bituminous coal industry. The United States Chamber of Commerce is to be heard in opposition to the bill, taking the position that government control in this instance would be a bad thing for all concerned.*

Chicago Drainage Canal Flow Reduced by Court Order

Ending a legal battle that has been waged for years between the City of Chicago and the states bordering the Great Lakes and the St. Lawrence River, the United States Supreme Court has just handed down a decision compelling that city to reduce the quantity of lake water which she has been diverting into the Chicago River for drainage purposes. Normally, the question of water withdrawal comes under the jurisdiction of the Secretary of War, but in an effort to solve her sewage problem, it is stated, Chicago has exceeded by more than double the allotment of water allowed her by the army head. The diversion, amounting to 8,500 sec.ft. has resulted in a perceptible lowering of the water level in the Great Lakes and the St. Lawrence River, with consequent curtailment of harbor depths and the flow of water at Niagara and other points where power is generated.

The decision, written by chief justice Taft, holds that the water has been diverted illegally, and a permanent injunction is therefore established against a continuance of the arrangement. A reasonable time will be given the city to build sewage disposal plants of sufficient capacity to serve the entire city.

Charles E. Hughes, as master of the special investigation which preceded the Supreme Court decision, found that a six-inch increase in the level of the lakes would have permitted shipping to carry 3,346,000 tons more freight in the year 1923 alone.

Waterwheel, 115 Years Old, Terminates Service

A link with the pioneer power development days of Canada was brought to light recently when it was discovered that a wooden waterwheel which had been continuously turning for 115 years in Greenville, Ontario, to furnish power for industrial operations, had stopped. The axle collapsed, and it was with difficulty that a gang of men made repairs. The wheel weighs over a ton and the supports are slung 35 ft. below the factory level. The wheel is installed in the Stutt Paper Mill, and a stone slab built into the wall makes known the fact that the apparatus, the most modern in its day, was placed in position in 1813.

Men In the News

ROBERT M. GATES, *well-known manager of the industrial department of the Superheater Company, New York City, has been elected vice-president of the company. Mr. Gates is an active A.S.M.E. member, and holds positions on the Council and on committees of that society.*

A. S. H. & V. E. to Have New Magazine

A. C. Willard, president of the American Society of Heating and Ventilating Engineers, announces that on May first, the Society's monthly publication, *The Journal,* will be combined with a new publication, to be known as *Heating, Piping and Air Conditioning,* which will also be issued monthly. By arrangement with the publishers, the Council of the Society has authorized the incorporation of *The Journal* as a separate section of this new publication and all meeting papers, laboratory reports and other announcements will appear in *Heating, Piping and Air Conditioning* after May 1, 1929, thereby making it the official organ of the Society. Mr. Willard continues:

"The new magazine will be $7\frac{7}{8}$ x $12\frac{5}{16}$ in. in size, and in addition to the Society's own papers, reports, news items, etc., will contain many technical articles in the other departments which will be of value to Society members. Thus, the members of the Society will benefit through receiving an added editorial service while non-member readers will benefit through having the additional privilege of receiving each month from 25 to 30 pages of editorial material covering the research and other engineering activities of the Society and its members.

The publishers of the new magazine have made an enviable record in the successful publication of *Domestic Engineering* for the last 40 years. A number from their organization are members of the Society and are well known to our membership."

As this notice of the new publication is published, heating and ventilating engineers from all over the country are making final preparations for the annual convention in Chicago, scheduled for Jan. 28-31. A full program of technical papers and entertainment features is in readiness, and the attendance is expected to be the largest in the history of the society.

John C. Dean Dead at 83

John C. Dean, president of Dean Brothers Company, manufacturers of pumping equipment in Indianapolis, Ind., died in that city on New Year's Eve, after a long illness. He had been active in the business since he, with his four brothers, founded it 57 years ago. He was also well known for his popular writings on astronomy, in which subject he took an almost professional interest.

Mr. Dean was born in Deansboro, N. Y., in 1845, and was educated at Whitestown Seminary. Subsequently the five brothers entered the foundry business in Utica, N. Y., establishing a factory which was run entirely by hydraulic power. Shortly after this, they moved to Indianapolis.

Mr. Dean was a member of the American Association for the Advancement of Science and of other scientific bodies. He was also prominent in literary circles in Indianapolis.

Government to Choose Boiler Inspectors

The United States Department of Labor will soon hold a competitive examination for the post of boiler inspector in the State of New York. The department's notice is as follows:

"Boiler Inspector, Department of Labor, Division of Boiler Inspection; $1,800 to $2,400 per year. Two immediate appointments expected at $1,800. Age limits, 25 to 40 years. Waist measurement not over 38 inches (measurement must be written at top of application blank). The duties are to inspect boilers in various parts of the State. Candidate must have had not less than three years of practical experience as a journeyman boiler maker, or three years of practical experience as a boiler inspector holding a certificate of competency, or five years of practical experience as operating engineer of a high-pressure steam boiler plant either stationary or marine, of more than 50 hp. capacity. Technical education will be given credit as equivalent to experience in proportion to its value, graduation from a mechanical engineering course for which a degree is granted being accepted as two years of the required experience. Subjects of examination: Written examination, including practical questions and calculations pertaining to boilers, relative weight, 4; training, experience and general qualifications, relative weight, 6. An interview will be required."

Trade Commission Continues Exhaustive Utility Inquiry

The Federal Trade Commission resumed its investigation into public utilities in Washington on Jan. 10. This marks the reopening of what already has become the most detailed and intimate inquiry ever conducted by the government into any single business or industry. The scope of the inquiry is indicated by the volume of testimony and exhibits in the record to date. Since March 8, 1928, when the inquiry was begun, demands for information and records have been made on more than 2,000 individual utility companies. Almost one hundred witnesses have been subpoenaed, 72 of whom have been examined. Their testimony so far fills 5,949 pages. In addition, there has been filed for the record a total of 4,047 exhibits. The partial record which the Commission has so far transmitted to Congress covers 2,349 printed pages, exclusive of exhibits. Already the record has run into many millions of words, and many millions more seem likely to be added before it is completed.

To date, the entire presentation has been by counsel for the Trade Commission. Testimony and evidence presenting the utilities side will require weeks, perhaps even months. As yet the utilities have not had their day in court. The Commission has sent to the public utility companies a questionnaire comprising more than 200 pages. The answers must be collated and analyzed by the Commission. This, if done in detail, will require the studying of more than 4,000,000 separate questions and answers, in addition to all the material contained in the testimony and exhibits taken at the hearings.

THIS is the famous "Christmas Plume," which caused wide comment in New Jersey during the holidays. Engineers of the Edison Lamp works at Harrison, hating to see even exhaust steam going to waste, illuminated it with many colors and thus developed what may become a valuable publicity idea for industrial plants.

N.E.L.A. Prize Awards

The Prize Award Committee of the National Electric Light Association has just issued a poster giving complete details of the awards to be made in seven prize groups for papers on various subjects relating to the electric light and power industry. Prizes range from $250 down. The contest will close April 1, 1929.

More Spot * News

THE IRISH FREE STATE *has been keeping tabs on the number of visitors to its new Shannon hydro-electric development. Since last May more than 100,000 people have shown their curiosity and interest in the undertaking, which will ultimately cost the Irish government six million pounds.*

* * *

MANUFACTURED GAS *is being used by a firm in New Brunswick, N. J., for firing the boilers of its plant. Besides the advantages of cleanliness and uniformity of temperature, a good deal of valuable space is reclaimed, which used to be occupied by the coal pile.*

* * *

ONE HUNDRED BILLION *kilowatt-hours of generated electricity per annum is not far distant, it may be inferred from the estimate of Pynchon & Company, which places the total central-station output for 1928 at eighty-one billion. This is 9 per cent above the 1927 figure of 74,335,000.*

* * *

NATURE LOVERS, *this time under the banner of the Garden Club of Virginia, are again participating in an attempt to prevent the alleged destruction of a waterfall for power purposes. The Virginia Public Service Corporation seeks a permit to build a dam and power plant at Goshen Pass, near Lexington, Ky.*

* * *

EIGHT CARLOADS *of electrical parts have been delivered to the New York Edison Company by the General Electric Company. When put together they will comprise another world's record generator—the 160,000-kw. unit for the East River station. The generator will have two separate windings of 80,000 kw. each.*

* * *

B. N. Duke, Power Company Founder, Dies

Benjamin N. Duke, last of the tobacco pioneers of that name and vice-president of the Southern Power Company, died in New York City on Jan. 8, at the age of 73. Mr. Duke, who started in North Carolina as a poor boy, rose to great wealth with his brother through the development of a tobacco manufacturing business founded by their father.

Some years later, the business was merged with the American Tobacco Company, and the two brothers became important figures in the direction of the corporation's affairs. In 1911, when the tobaco trust was dissolved by the action of the United States Supreme

Court, Mr. Duke turned his attention to industrial and educational enterprises in the South, prominent among which were public utilities. At this time he founded the Duke Power Company, which was engaged in the development of hydro-electric power in North and South Carolina. Although Mr. Duke retired from active participation in business affairs some years ago, he was still a vice-president of the Southern Power Company at the time of his death.

OBITUARY

BENJAMIN W. TUCKER, of South Orange, N. J., an internationally known mechanical engineer, died at his home Jan. 11, after an illness of three years. He was born in Newark, June 25, 1864, and was graduated from Stevens Institute of Technology at Hoboken in 1884, with the degree of mechanical engineer. Until 1890 he was employed as an engineer by the Hyatt Roller Bearing Company in Harrison. In that year he opened an office in Newark as a consulting engineer. He later moved his office to New York, where he remained until 1925, when his health failed. He was at one time consulting engineer to the American Tobacco Company. His work took him to England, France, Spain and Mexico.

With the Society Sections

A. S. M. E., Knoxville Regional Meeting, Mar. 21-23, 1929. Technical program and trips to points of interest.

A. S. M. E., Metropolitan Section. Meeting of the power division Feb. 4, at the Engineering Societies Building, New York City. Subject: "High Pressure Steam-Electric Generating Stations."

A. S. M. E., San Francisco Section. Joint meeting with the A. I. E. E. and the A. S. C. E., on Jan. 25. Subject: "Electric Welding of Steel Buildings and Bridges," by F. P. McKibben, consulting engineer.

A. S. M. E., Waterbury, Conn., Section. Meeting, Jan. 24. Subject: "Radial Aircraft Motors," by E. H. Godfrey, Pratt & Whitney Aircraft Company.

A. S. M. E., Oregon Section. Portland, Oregon, Jan. 25. Subject: "Lubrication of Internal Combustion Engines," by Prof. F. C. Baender, Corvallis, Ore.

American Water Works Association, Kentucky-Tennessee Section. Annual meeting, to be held at Chattanooga, Tenn., Jan. 24-26, 1929.

American Water Works Association, Montana Section. Annual convention, to be held April 4 and 5 at Great Falls, Mont.

American Water Works Association, Rocky Mountain Section. Annual meeting, to be held Feb. 14 and 15, at Denver, Colo.

Engineers' Club of St. Louis. Meeting Feb. 13, 1929. Subject: "Steam Storage and Steam Distribution," by R. A. Longworthy, vice-president and general manager of Ruths Accumulator Company.

PERSONALS

A. W. MASON, formerly employed at the Algonguin Hotel, St Andrews, N. B., Canada, has been appointed chief engineer of the Canadian Pacific Railroad's Royal York Hotel, Toronto, Ontario.

EDWARD DEAN ADAMS, electrical engineer and chairman of the committee on the war memorial to American engineers in Belgium, received on Jan. 7 the insignia of Commander of the Belgian Order of the Crown. The committee had presented a carillon and clock to the University of Louvaine, on behalf of three thousand American engineers.

MAGNUS BJORNDAL has resigned his position in the engineering department of the Electric Bond & Share Company and accepted the position of chief engineer with Hardwick, Field, Incorporated, electrical and mechanical manufacturers, of Newark, N. J.

R. H. STEVENS, formerly located at the headquarters sales at the South Philadelphia Works of the Westinghouse Electric & Manufacturing Company as assistant to C. G. Ong, manager, Small Turbine Sales, has been transferred to the Philadelphia district office of that company.

FRANK R. WHEELER, who has been intimately connected with the condenser business for the last 25 years, has been appointed manager of the condenser department of the Elliott Company, with offices at Jeannette, Pa. Mr. Wheeler took charge of his new duties Jan. 1.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.35@$2.40
Kanawha	Columbus	1.25@1.45
Smokeless	Cincinnati	2.25
Smokeless	Chicago	2.25
S. E. Kentucky	Chicago	1.35@1.60
Steam	Pittsburgh	1.60@1.70
Gas Slack	Pittsburgh	.75@.90
Big Seam	Birmingham	1.25@1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.75@$3.25
Barley	New York	1.00@1.75

FUEL OIL

New York—Jan. 17, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4¾c. per gal.; 36@40 deg., furnace, tank-car lots, 6¼c. per gal.

St. Louis — Jan. 8, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.40 per bbl. or 42 gal.; 26@28 deg., $1.45 per bbl.; 28@30 deg., $1.50 per bbl.; 30@32 deg., $1.55 per bbl.; 32@36 deg., gas oil, 4.65c. per gal.; 38@40 deg., distillate, 5.625c.

Pittsburgh—Jan. 8, f.o.b. local refinery, 30@34 deg., fuel oil 4¾c. per gal.; 36@40 deg., 5c. per gal.

Philadelphia—Jan. 16, 13@19 deg., $0.95@$1.02 per bbl. or 42 gal.; 22 deg. plus, $1.47@$1.53 per bbl.; 26@30 deg., $2.00@$2.06 per bbl.

Cincinnati — Jan. 15, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5¼c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Jan. 17, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 72½c. per bbl.; 30@32 deg., 97½c.@$1 per bbl.

Boston—Jan. 14, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.52c. per gal.; 28@32 deg., 5.65c. per gal.

Dallas—Jan. 12, f.o.b. local refinery, 26@30 deg., $1.25 per bbl. or 42 gallons.

Coming Conventions

American Boiler Manufacturers Association, mid winter meeting, Cleveland, Ohio, Feb. 5, 1929. A. C. Baker, secretary, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineers, annual winter convention, New York City, Jan. 28-Feb. 1; annual summer convention, Swampscott, Mass., June 24-28; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, at Washington, May, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Oil Burner Association, annual convention, Hotel Pennsylvania, New York City, April 9-11, 1929. For information, address the headquarters of the Association at 420 Madison Ave., New York City.

American Society of Heating and Ventilating Engineers, 35th annual meeting, Chicago, Ill., Jan. 28-31, 1929. A. V. Hutchinson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers, spring meeting, Salt Lake City, Utah, July 1-4, 1929. Calvin Rice, secretary, 29 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Canadian Electrical Association, annual convention, to be held June 19-21, at St. Andrews-by-the-Sea, N. B. H. M. Lyster, secretary, Power Building, Montreal, Que.

Engineering Institute of Canada, annual general and professional meeting, at Hamilton, Ont., Feb. 13-15, 1929. R. J. Durley, secretary, 2050 Mansfield St., Montreal, Que.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 12-16; Conference headquarters at the Palmer House, Exhibition at the Coliseum; G. E. Pfisterer, secretary 53 West Jackson Blvd., Chicago.

National Marine Engineers Beneficial Association. The 54th annual meeting will be held in Washington, D. C., Feb. 11-16, at the Hotel Hamilton.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

Business Notes

The General Refractories Company, Philadelphia, Pa., has changed the address of its Detroit office to 6-230 General Motors Bldg. This office will continue to be in charge of J. L. Graham.

The Timken Roller Bearing Company announces the appointment of Judd W. Spray as vice-president and general sales manager. He has been general sales manager of the company since 1926.

The Lincoln Electric Company, Cleveland, Ohio, announces that it has released a three-reel motion picture film entitled, "Modern Manufacturing with a 'Stable-Arc' Welder."

D. K. Swartwout, Jr., vice-president and general manager of The Swartwout Company, recently announced the transfer of all the company's operations to Cleveland, Ohio. Outright purchase of the "S-C" Regulator Company, of Fostoria, Ohio, and need of larger quarters to accommodate the growing output of the Swartwout factory at Orrville, Ohio, demanded a central production point, Mr. Swartwout said.

Trade Catalogs

Sewage Ejectors—Yeomans Brothers Company, Chicago, Ill., is sending out upon request Bulletin No. P-4400, a new twenty-page publication covering the six types of Shone, screenless, pneumatic sewage ejectors. Details on application, operation and installation are given, including tables of physical dimensions of the ejectors and of the electric compressor plant to operate them.

Diesel Engines—A summary of the operating expenses of a 365-hp. Diesel engine at Elko, Nev., is contained in a booklet just issued by the Busch-Sulzer Diesel Engine Company, St. Louis, Mo. The engine had non-stop runs as long as 211 days. Repair expenses totaled $321 in approximately six years.

Furnaces—In an eight-page bulletin recently issued, the Erie City Iron Works describes its Seymour-Carbofax furnace as installed in the power plant of the Carborundum Company, Niagara Falls, N. Y.

Electric Space Heaters—In Booklet H-4, the Cutler-Hammer Manufacturing Company, Milwaukee, Wis., presents information on the uses of its line of electric space heaters. The publication contains 24 pages, and is well illustrated.

Regulators—"Sylphon" pressure and vacuum regulators are the subjects treated in Bulletin P-100, published by the Fulton Sylphon Company, Knoxville, Tenn. Illustrations, tables and descriptive text fill the twenty pages of the booklet.

Regulating Valves—The Watts Regulator Company, Lawrence, Mass., has issued an eight-page booklet illustrating its many types of regulating valves for all power plant purposes.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Alabama—Alabama Power Co., T. W. Martin, Pres., 600 North 18th St., Birmingham, plans to expend $17,000,000 for construction program in 1929. Plans include completion of the Gorges steam power plant on Warrior River, initial capacity 80,000 hp. and reconstruction of Tallahassee development, 84,000 hp.

Calif., Long Beach—Southern California Edison Co., 537 Pine St., awarded contract for a 186 x 235 ft. addition to power plant, including 3,416 hp. Babcock & Wilcox water tube boilers, etc., to Stone & Webster, Laughlin Bldg., Los Angeles. Estimated total cost $1,300,000.

Calif., Los Angeles — Barlett Syndicate Building Corp., Rives-Strong Bldg., is having preliminary plans prepared for a 12 story office and theatre building, including steam heating system, electric elevators, etc., at Hollywood Blvd. and Argyle St. Estimated cost $2,500,000. B. Marcus Priteca, 912 Pantages Theatre Bldg., is architect.

Calif., Los Angeles — Missionary Sisters of Sacred Heart, is having preliminary plans prepared for an 8 story hospital, including steam heating system, electric elevators, etc., at Hill St. and Sunset Blvd. Estimated cost $800,000. R. Meier, 402 Rowan Bldg., is architect.

Calif., San Francisco—Shell Co. of California, 200 Bush St., is having plans prepared for the construction of a 20 story office building at Bush and Battery Sts. Estimated cost $3,000,000. G. W. Kelham, 315 Montgomery St., is architect.

Calif., San Pedro — Los Angeles Hot Springs Co., M. D. Joseph, Pres., 280 Leo St., Oakland, is having preliminary plans prepared for the construction of a hotel at Point Firmen. Estimated cost $3,500,000. H. Brelin, 2817 Regent St., Berkeley, is architect.

Ill., Chicago—Otis Building Co., 10 South La Salle St., awarded contract for a 25 story office building at Van Buren and Wabash Sts., to Lundoff-Bicknell Co., B. F. Keith Bldg., Cleveland, O. Estimated cost $2,000,000. Steam heating system, etc., will be installed.

La., Marrero — Celotex Co., 645 North Michigan Ave., Chicago, Ill., plans addition to steam power plant here. Estimated cost $1,000,000. Private plans.

Mass., Norfolk — Dept. of Correction, State House, will build a prison to include power house, etc. Estimated cost $200,000. McLaughlin & Burr, 88 Tremont St., Boston, are architects. R. D. Kimball Co., 6 Beacon St., Boston, is engineer. Work will be done by day labor.

Mich., Dearborn—Henry Ford, is having plans prepared for the construction of a museum group including power house, etc. Estimated cost $7,000,000. R. O. Derrick, Inc., 120 Madison Ave., Detroit, is architect.

Mich., Detroit—Murray Body Corp., Russell and Colby Sts., will soon award contract for the construction of a 40 x 75 ft. power house, boiler house, and coal storage plant. Estimated cost $50,000. A. Kahn Inc., 1000 Marquette Bldg., is architect.

Mich., Detroit—Owner, c/o H. J. Darling, First National Bank Bldg., Archt., is having plans prepared for the construction of an 8 story hotel, including steam heating, ventilation and refrigeration systems, boilers, elevators, etc. Estimated cost $1,000,000.

Mich., Lansing—Ingham Co., Bd. of Supervisors plans the construction of a group of hospital buildings including power house, etc., at South Washington St. Estimated cost $300,000. Bowd & Munson, 409 Wilson Bldg., are architects. McColl, Snyder & McLean, 2304 Penobscot Bldg., are engineers.

Minn., Minneapolis — Northwestern National Bank Building Co. H. B. Waite, chn. of Bldg. Comm., Frontenac Bldg., awarded contract for the construction of a 16 story, bank and office building at Marquette Ave. between 6th and 7th Sts., to C. F. Haglin & Sons Co., 920 National Bldg. Estimated cost $4,000,000. Steam heating system, etc., will be installed.

Miss., Ellisville—Mississippi School and Colony for Feeble Minded, c/o State Building Commission, W. C. Trotter, Secy., Jackson, will soon receive bids for the construction of a group of hospital buildings, including pump house, power house, etc., here. Estimated cost $300,000. C. H. Lindsley, Lamar Life Bldg., Jackson, is architect. Gardner & Howe, Porter Bldg., Memphis, Tenn., are engineers.

Neb., Glenvil—City, J. J. Mohlman, Clk., is having plans prepared for a waterworks and distribution system, including pump house, pump, etc. Estimated cost $25,000. Nixon & Reynolds, Omaha Grain Exchange Bldg., Omaha, are engineers.

N. J., Asbury Park — Monmouth Title Mortgage & Guaranty Co., 416 Main St., is having plans prepared for the construction of a 15 story office building including steam heating and ventilation systems, boilers, pumps, elevators, etc. on Main St. Estimated cost $750,000. P. Freshman, 50 Court St., Brooklyn, N. Y., is architect.

N. J., Jersey City — Owner, c/o P. Simeone & Co., Inc., 22 Journal Sq., Archts. and Engrs., is having plans prepared for the construction of a 60 x 76 ft. power house, including 600 kw. engine, 500 hp. boiler, etc. Estimated cost $150,000.

N. J., Long Branch—W. H. Pawson, 25 West 43rd St., New York, N. Y., plans the construction of a hotel on Ocean Ave., here. Estimated cost $3,000,000. Ellis, Aaronson & Heedrich, 25 West 43rd St., New York, N. Y., are architects.

N. J., Newark—Bd. of Comrs., City Hall, plans the construction of a 5 story apartment building, including steam heating system, etc. Estimated cost $1,000,000. Architect not selected.

N. J., Newark—Newark Memorial Hospital, W. F. Hoffmann, Treas., 340 Bank St., is having sketches made for the construction of a 10 story hospital including steam heating system, etc. on Newton St. Estimated cost $1,250,000. Guilbert & Betelle, 20 Branford Pl., are architects.

N. J., Newark—Singer Ice Co., 746 South 14th St., awarded contract for the construction of an ice plant at South 14th and Pierce Sts., to Robert Allen Inc., 319 Mt. Pleasant Ave. Estimated cost $75,000.

N. Y., New York — Fourteen East 90th St. Corp., J. H. Carpenter, Pres., will build a 12 story apartment building at 1244 Madison Ave. Estimated cost $1,200,000. J. E. R. Carpenter, 598 Madison Ave., is architect. Work will be done by separate contracts.

N. Y., New York — Thirty-Seven West 72nd St. Corp., R. E. LaBarre, Pres., awarded contract for a 15 story apartment building at 35-39 West 72nd St., to James Stewart & Co., 17 East 42nd St. Estimated cost $1,000,000. Electrical refrigeration system, etc., will be installed.

O., Cincinnati—Union Gas & Electric Co., 4th and Plum Sts., awarded contract for the construction of a 15 story office building at 4th and Main Sts., to G. A. Fuller, 59 M St. N. E., Washington, D. C. Estimated cost $2,000,000.

O., Cleveland—Owner, c/o B. S. Hubbell, Sr., 4500 Euclid Ave., is having plans prepared for a 14 story hotel, including steam heating, ventilation and refrigeration systems, boilers, elevators, etc., at East 107th St. and Derring Ave. Estimated cost $2,000,000. Hubbell & Benes Co., 4500 Euclid Ave., are architects.

O., Cleveland — University Hospitals of Cleveland, M. S. Potter, Secy., 10940 Euclid Ave., is having plans prepared for addition to power house at Euclid Ave. and Adelbert Rd. Coolidge, Shepley, Bulfinch & Abbott, Ames Bldg., Boston, Mass., are engineers and architects.

Okla., Hooker—Oklahoma Electric Power Co. is having preliminary plans prepared for the construction of a new electric power plant. Estimated cost $25,000. Private plans.

Okla., Oklahoma City—Oklahoma Gas & Electric Co., Insurance Bldg., is having plans prepared for the construction of new sub-stations at Creston Hills and Nichols, additions. Estimated cost $35,000. Byllesby Engineering Co., 231 South La Salle St., Chicago, Ill., is engineer.

Pa., Colfax—Duquesne Light Co., 6th Ave., Pittsburgh, will soon award contract for a 60 x 138 ft. addition to electric light plant here. Estimated cost $40,000. Private plans.

S C., Ferguson — Columbia Railway & Navigation Co., subsidiary of International Paper Co., 100 East 42nd St., New York, N. Y., plans the construction of a hydro-electric development on the Santee and Cooper rivers at Pinopolis and Moncks Corner. Plans include power house and dam; initial installation of two power units, 20,000 to 25,000 kw. each and an ultimate installation of eight units with combined capacity of 175,000 kw. Estimated cost $1,000,000. Murray & Flood, 369 Lexington Ave., New York, are engineers. Bulk of work will be done by day labor. International Paper Co. also plans a pulp mill at same location to cost $3,000,000.

Tex., Austin—City Council plans the construction of an auxiliary power plant. Estimated cost $460,000.

Tex., Brady—Spiller Grain & Cold Storage Co. plans the construction of a 9 ton ice plant in connection with cold storage plant.

Tex., Sulphur Springs—Burnett, White & Co., plans the construction of a 15 ton ice plant. Estimated cost $32,000.

Ont., Kingston—Hotel Dieu Hospital is having plans prepared for a 3 or 4 story addition to hospital, including steam heating system, etc. Estimated cost $700,000. C. Drever, 81 Brock St., is architect.

Ont., Toronto—Atlas Finance & Development Co., 1126 Bay St., is having plans prepared for the construction of a 15 story apartment building including steam heating and refrigeration systems, elevators, etc. Estimated cost $1,000,000. N. A. Armstrong Co., Ltd., 7 King St. E., are architects.

Ont., Toronto — Bd. of Education, 155 College St., plans the construction of a technical school, including steam heating and mechanical ventilation systems, etc. Estimated cost $1,000,000. C. E. Dyson, 155 College St., is architect.

Ont., Toronto—Canadian Bank of Commerce, 21 King St. W., awarded general contract for the construction of a 30 story office building on King St. W., to Anglin-Norcross Ltd., Temple Bldg. Estimated cost $5,000,000. Steam heating, elevators, etc., will be installed.

Ont., Toronto—Toronto Harbor Commission, Harbor, is having plans prepared for the construction of an electrically operated steel rolling lift bridge, 120 ft. span over ship channel on Cherry St. Estimated cost $300,000. J. G. R. Wainwright, Harbor Bldg., is engineer.

Ont., Toronto — Canada Life Assurance Co., 46 King St. W., plans the construction of an office building including steam heating system, elevators, etc. on University Ave. Estimated cost $1,000,000. Sproatt & Rolph, 1162 Bay St., are architects.

Ont., Toronto—Yolles & Rotenberg, Federal Bldg., plan the construction of a 30 story office building, including steam heating system, elevators, etc. Estimated cost $2,500,000. Architect and engineer not selected.

Rumania, Bucharest—City of Bucharest awarded contract for the construction of two hydro-electric power stations, one 15,000 hp. capacity and one 10,000 hp. to Brown-Boveri & Co., 420 Lexington Ave., New York, N. Y.

Equipment Wanted

Air Blowers—City of Stettler, Alta., will receive bids until Feb. 5 for two motor driven air blowers, 100 cu.ft. capacity each for proposed sewage disposal works.

Air Compressor, Pumps, etc.—J. D. Bartlett, Mgr., Amarillo, Tex., will receive bids Jan. 29 for air compressor, two air lift pumps and 6 m.g.m. centrifugal pump for proposed waterworks improvements. Estimated cost $90,000.

Boilers—Superintendent of Lighthouses, Portland, Me., will receive bids until Feb. 4 for furnishing and installing Scotch or water tube boilers in lighthouse tender "Hibiscus."

Boilers, Engines, Generators and Coal Handling Equipment—Murray Body Corp., Russell and Colby Sts., Detroit, Mich., is in the market for steam boilers, engines, generators and coal handling equipment for proposed 40 x 75 ft. power house and coal storage plant.

Engine and Generator—County Supervisors, Los Angeles, Calif., will receive bids until Feb. 4 for furnishing and installing one vertical uniflow steam engine direct connected to 600 kw. d.c. generator for County General Hospital.

Motors, Switchboards, etc.—Sewerage & Water Board, G. G. Earl, Secy., 526 Carondelet St., New Orleans, La., will receive bids until Feb. 27 for furnishing and installing motors, switchboards and accessories for proposed extension to drainage pumping station.

Pump, Motor, etc. — City of Edmond, Okla., plans to purchase pump, motor, etc., for proposed waterworks improvements. Estimated cost $27,000.

Pump, Motor, etc.—K. C. Stoner, Clk., Unadilla, Neb., will receive bids until Feb. 1 for a 40 g.p.m. pump and motor, etc., for proposed waterworks improvements. Estimated cost $13,600.

Pump, Motor, etc.—Water & Light Committee, Borough Hall, Madison, N. J., will receive bids until Jan. 28 for 1,500 g.p.m. electrically operated centrifugal pump, motor, etc., for proposed pumping plant.

Pumping Equipment—City of Beaumont, Tex., plans to purchase pumping equipment for proposed waterworks improvements.

Pumps—City of Hamilton, Ont., W. Burton, City Hall, Mayor, will receive bids until Feb. 20 for three horizontal centrifugal booster pumps for Ferguson Ave. pumping station.

Pumps — Lindsay-Strathmore Irrigation Dist., H. R. Huebert, Secy., Lindsay, Calif., will receive bids until Jan. 26 for three direct connected horizontal centrifugal pumps combined capacity of 35 sec.ft.

Pumps and Motors — City of Hebron, Neb., R. A. Young, Clk., will receive bids until Feb. 4 for two deep well turbine pumps and motors, etc., for proposed waterworks improvements.

Radiobeacon Transmitters — Supt. of Lighthouses, 3760 East Jefferson Ave., Detroit, Mich., will receive bids until Feb. 1 for low power radiobeacon transmitters.

Switchgear — Dept. of Public Works, Supplies & Tenders Board, Wellington, N. Z., will receive bids until Feb. 12 for a generating switchgear and controlling equipment.

Transformers—Utilities Commission, W. S. West, Chn., Woostock, Ont., plans to purchase additional transformers to relieve present overload on equipment. Estimated cost $25,000.

Transformers, etc.—City of Cleveland, O., will receive bids until Jan. 25 for lead covered cable; subway type distribution transformers and valves, fittings and flanges for division of light and power.

Transformers, Switchgear, etc.—Dept. of Public Works, Supplies & Tenders Board, Wellington, N. Z., will receive bids until Mar. 19 for 110,000 v. transformer; 1,500 kva., 3 ph. transformer with spare terminal bushings, etc.; 1,000 kva., 30 phase transformer with spare terminal bushings, etc., 11,000 v. switchgear.

Industrial Projects

Calif., Los Angeles—TIRE and RUBBER FACTORY and BOILER PLANT—Samson Tire & Rubber Co., 733 East 8th St., is having preliminary plans prepared for the construction of a factory, to include machine shop, pump plant, boiler plant, cooling towers, etc., at Telegraph Rd. and Atlantic Blvd. Estimated cost $1,000,000. Morgan, Walls & Clements, 1134 Van Nuys Bldg., are architects.

Calif., Pittsburg — STEEL MILL — Columbia Steel Co. plans the construction of a mill. Estimated cost $2,500,000. Work will be done by owner's forces.

Md., Baltimore—FACTORY (BAKERS' UTENSILS)—E. Katzinger Co., 1949 Cicero Ave., Chicago, Ill., will soon award contract for a 2 story, 143 x 180 ft. factory at Fleet and Haven Sts., here. Lockwood, Greene Co., 24 Federal St., Boston, Mass., are architects and engineers.

Mich., Detroit—AUTOMOBILE PLANT ADDITION—Packard Motor Car Co., East Grand Blvd., is having preliminary plans prepared for a 4 story, 115x425 ft. addition to automobile plant on East Grand Blvd. Estimated cost $450,000. A. Kahn, 1000 Marquette Bldg., is architect.

Mich., Ecorse (mail Detroit)—CHEMICAL PLANT—Grasselli Chemical Co., Div. E. I. du Pont de Nemours, du Pont Bldg., Wilmington, Del., plans the construction of first unit of chemical plant here. Estimated to cost $1,000,000. Architect not selected.

N. J., Kearny (Sta. Arlington)—FACTORY—Western Electric Co., 195 Broadway, New York, N. Y., awarded contract for a 6 story, 120x420 ft. factory to Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $1,000,000.

O., Newton Falls — STEEL PLANT — Newton Steel Co., First National Bank Bldg., Youngstown, plans extensions and improvements to steel plant here. Estimated cost $10,000,000 to $15,000,000.

O., Tiffin—CLAY REFRACTORY PRODUCTS FACTORY and BOILER HOUSE—American Clay Forming Co. awarded contract for the construction of a factory and boiler house, to L. Tyler, Tiffin. Estimated cost $50,000.

Pa., McKeesport — TUBE MILL — National Tube Co., F. W. Waterman, Pres., subsidiary of United States Steel Corp., 71 Broadway, New York, N. Y., is having plans prepared for the construction of a new seamless tube mill to replace old butt and lapweld mill here. Estimated cost $20,000,000. Private plans.

Tenn., Alcoa—ROLLING MILL—United States Aluminum Co., subsidiary of Aluminum Corp. of America, Oliver Bldg., Pittsburgh, Pa., R. L. Streeter, V. Pres. and Gen. Mgr., plans a 100 x 900 ft. addition to plant here, equipped for production of duralumin and alclad, metal used in airplane manufacture and in railway cars, etc., 1,000,000 lbs. of sheet metal per month capacity. Estimated cost $1,000,000.

Tex., Lubbock—CREAMERY and POULTRY PLANT and POWER HOUSE—Western Produce Co., W. R. White, Jr., plans the construction of a 2 story creamery and poultry plant to include power house, packing coolers and freezers, ice machines, etc. Estimated cost $200,000. Private plans.

Va., Hopewell—NITROGEN PLANT—Allied Chemical & Dye Co., 61 Broadway, New York, N. Y., plans the construction of second unit of nitrogen plant here. Estimated cost $35,000,000. Private plans.

Ont., New Toronto—BRASS PLANT ADDITION—Anaconda American Brass Co., 8th St., plans a 2 and 3 story addition to brass plant. Estimated cost $500,000. Private plans.

Ont., Toronto—PLATE AND STEEL FABRICATING PLANT—Toronto Iron Works, Cherry St., plans the construction of a 1 and 2 story plant on Eastern Ave. Estimated cost $500,000. D. Brouse, 514 King St. E. is architect.

Que., St. Hyacinthe—CANNING PLANT and BOILER ROOM — Quebec Canners Corp., St. Francois St., is having plans prepared for the construction of a 2 story, 50 x 150 ft. factory, 1 story, 40 x 200 ft. warehouse, and 40 x 40 ft. boiler room on Bourdages St. Estimated cost $120,000. Work will be done by day labor under the supervision of owner.